IASI Principle Component Analysis, IASI and AIRS Regression Retrieval Comparisons and Update on Radiance Climatology Dataset

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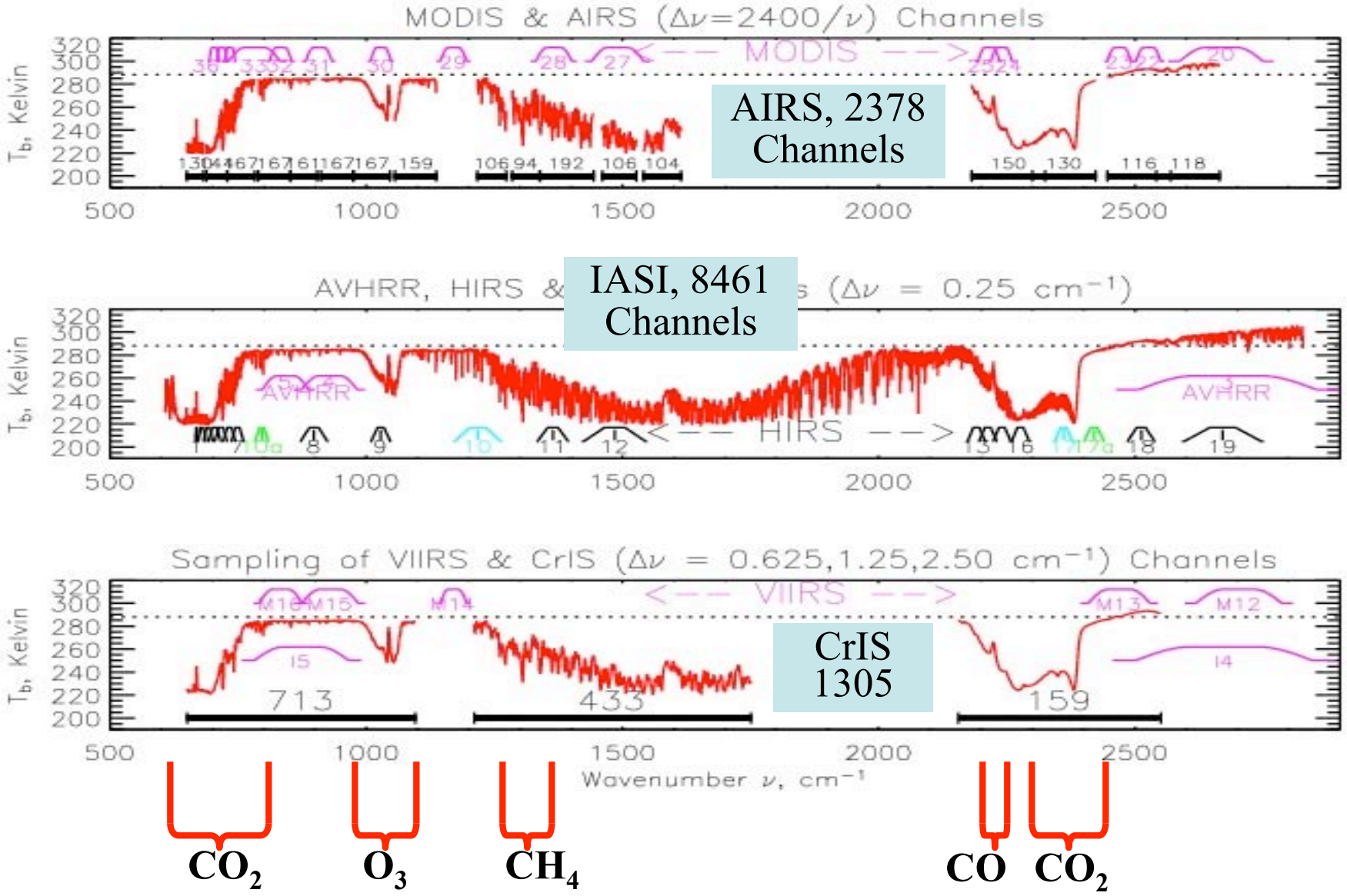
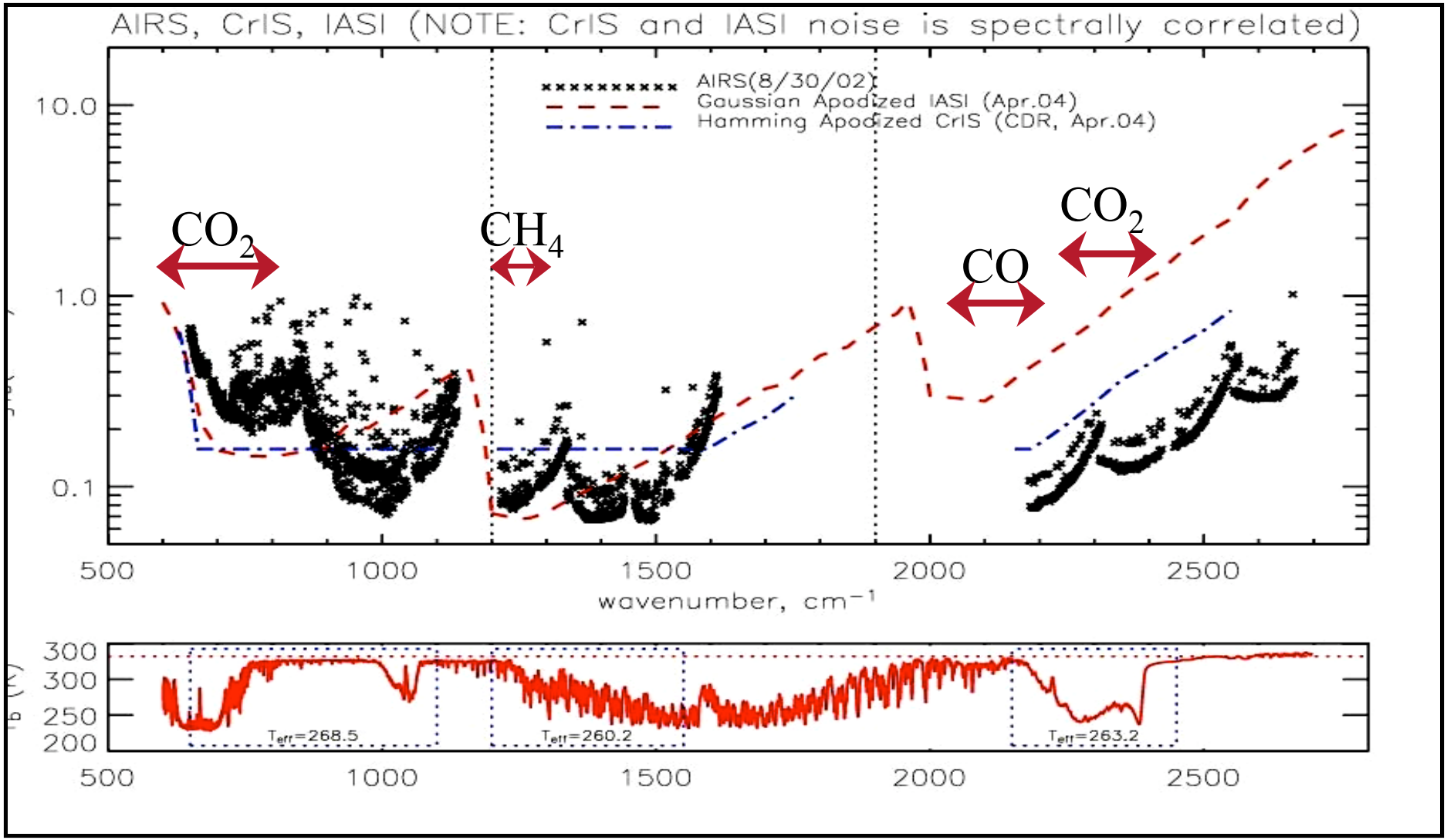
IASI PCA Motivation

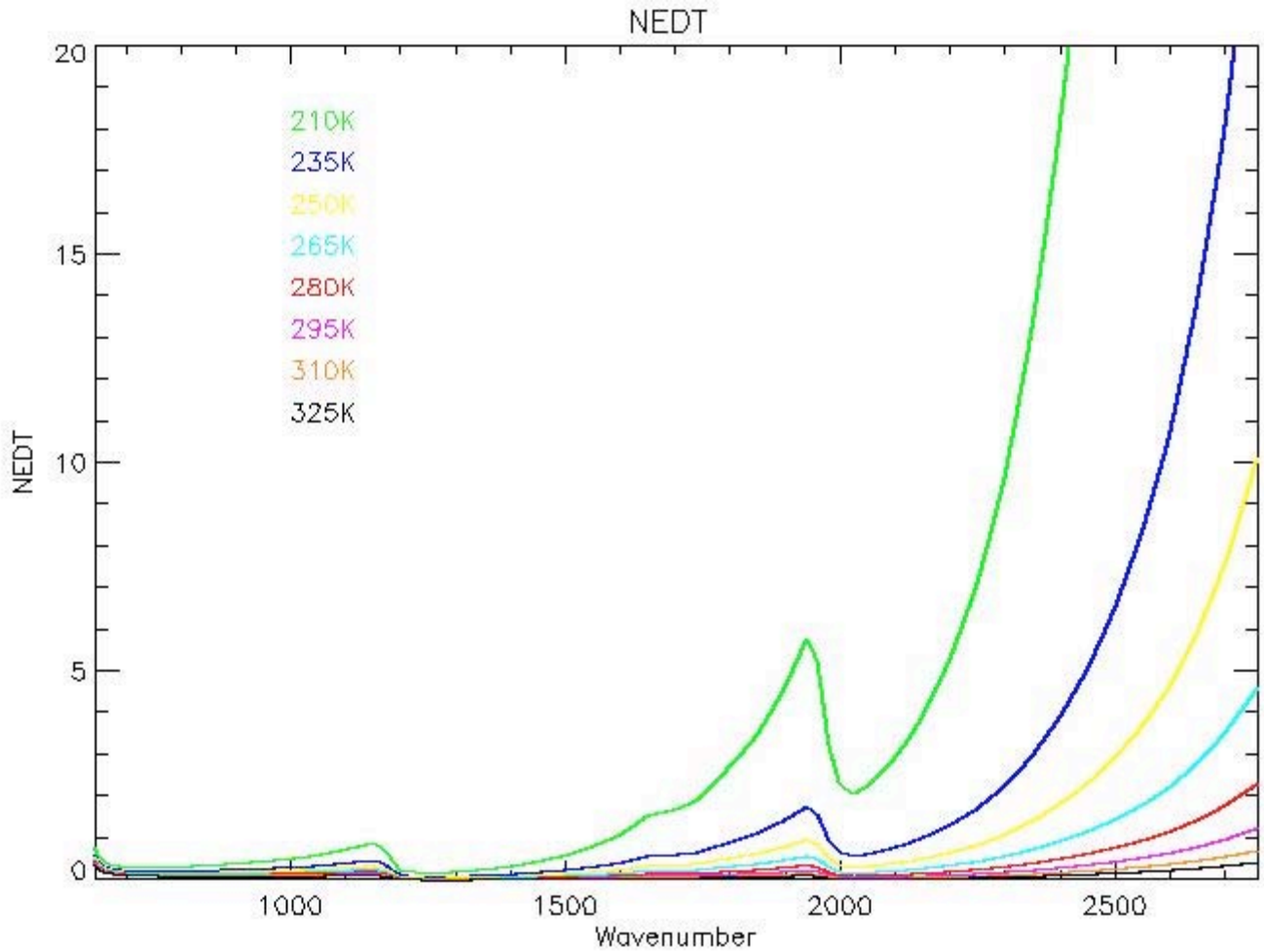
- IASI PCA Regression
- Data Compression
- Noise Estimation
- Detection of Anomalies
- Assimilation of Reconstructed Radiances
- Assimilation of PCs

Spectral Coverage of Thermal Sounders (Example BT's for AIRS, IASI, & CrIS)



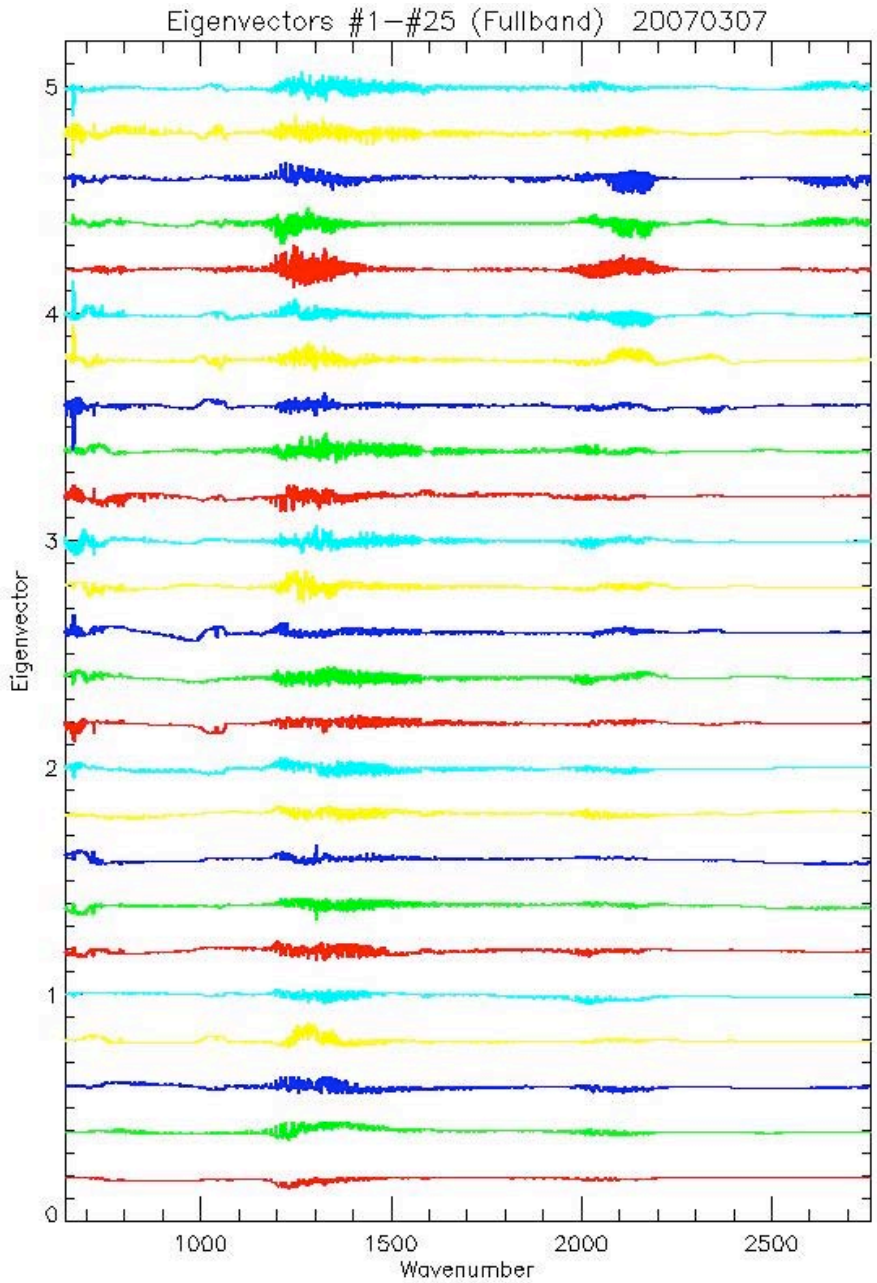
Instrument Noise, NEΔT at 250 K (Interferometers Noise Is Apodized)

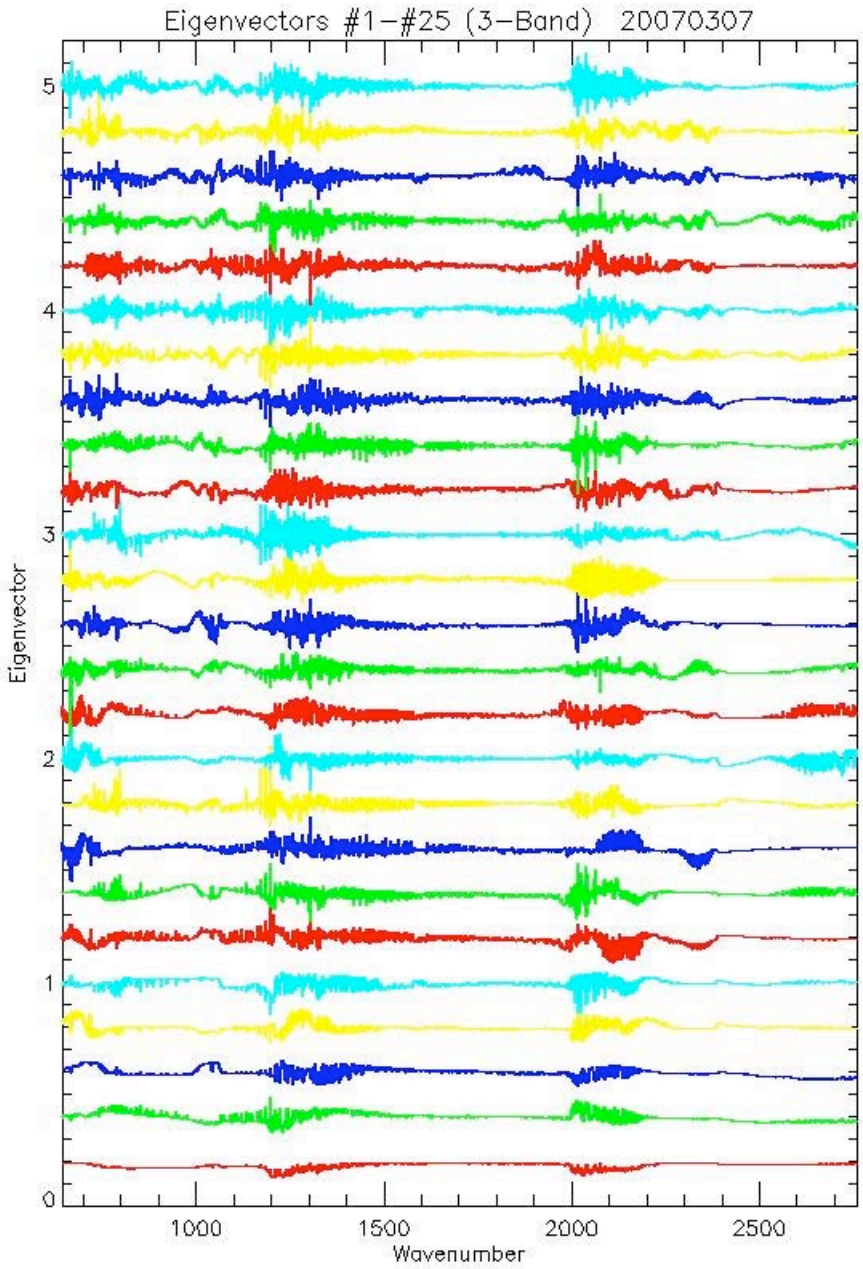


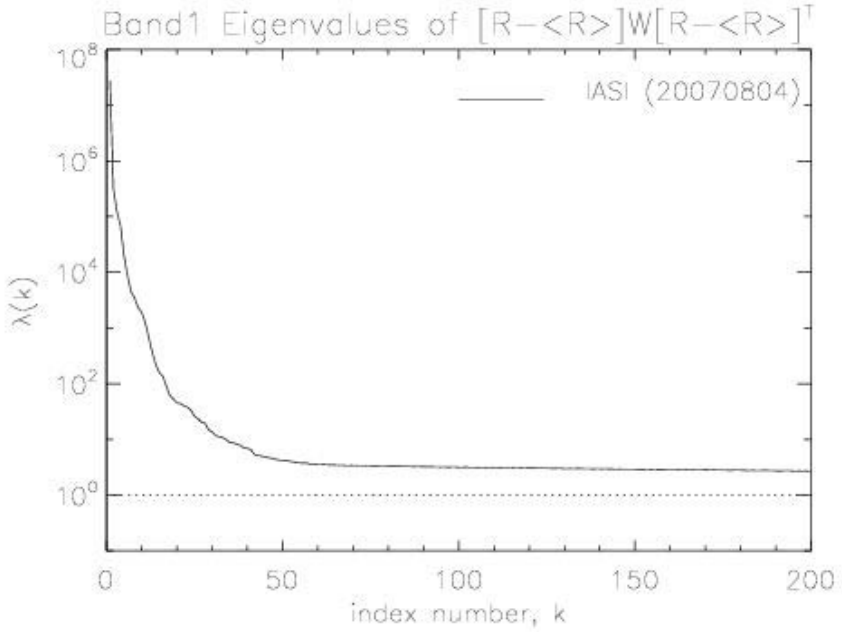

NEDT
210K
235K
250K
265K
280K
295K
310K
325K
NEDT
20
15
10
5
0
1000
1500
2000
2500
Wavenumber

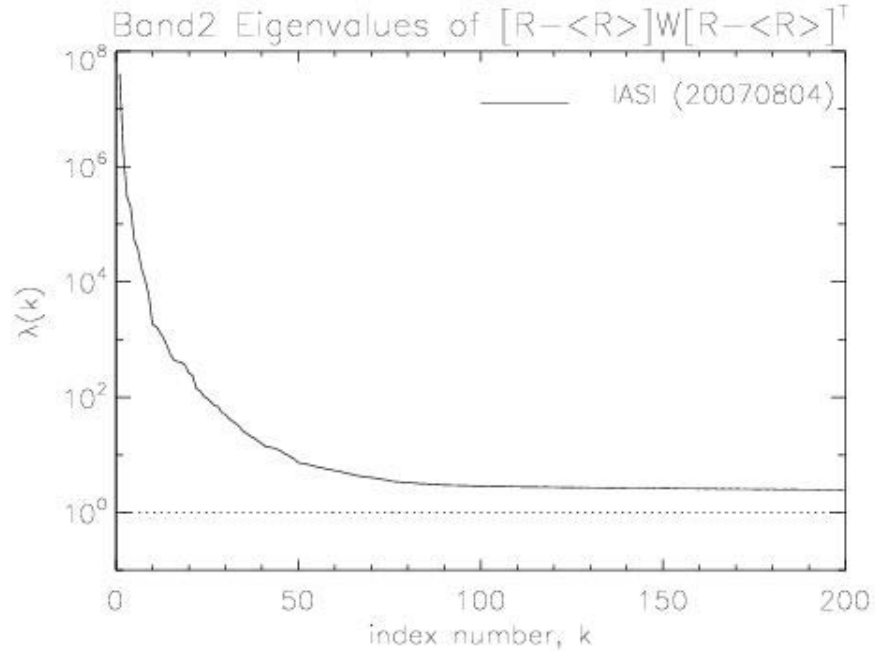
Generation of EOFs

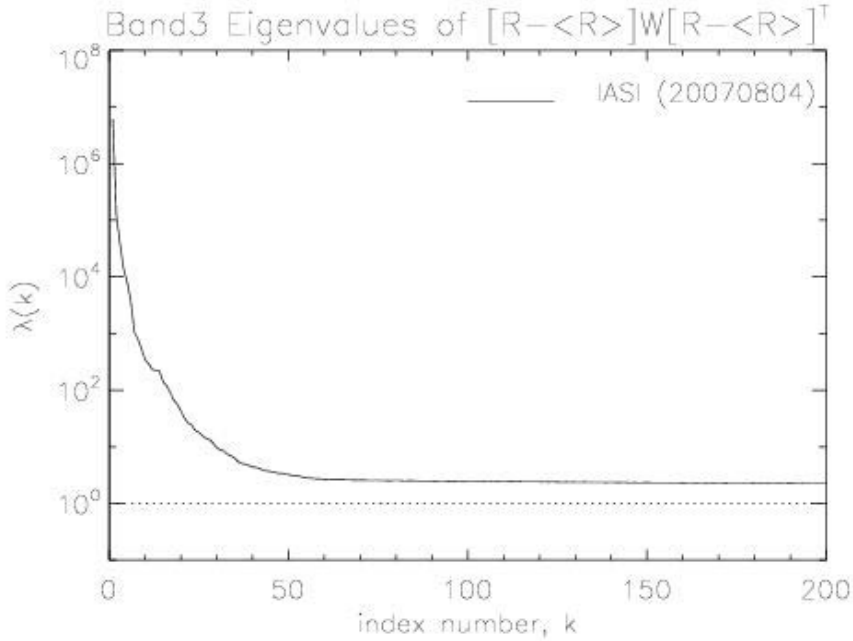
- 3 bands together
- Separate Bands
  - 645- 1210 cm-1
  - 1210 – 2000
  - 2000 - 2760

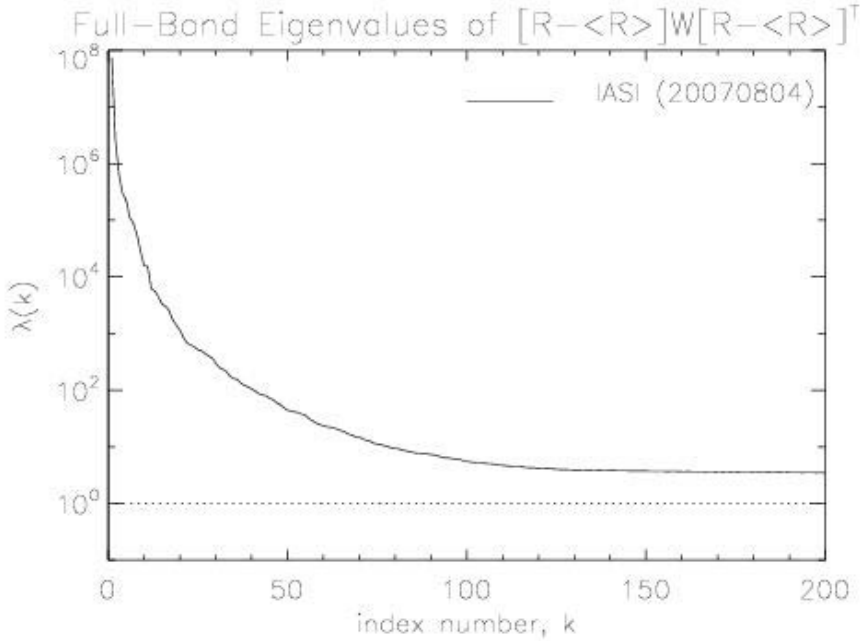

Eigenvectors #1–#25 (Fullband) 20070307
Eigenvector
Wavenumber
0
1
2
3
4
5
1000
1500
2000
2500

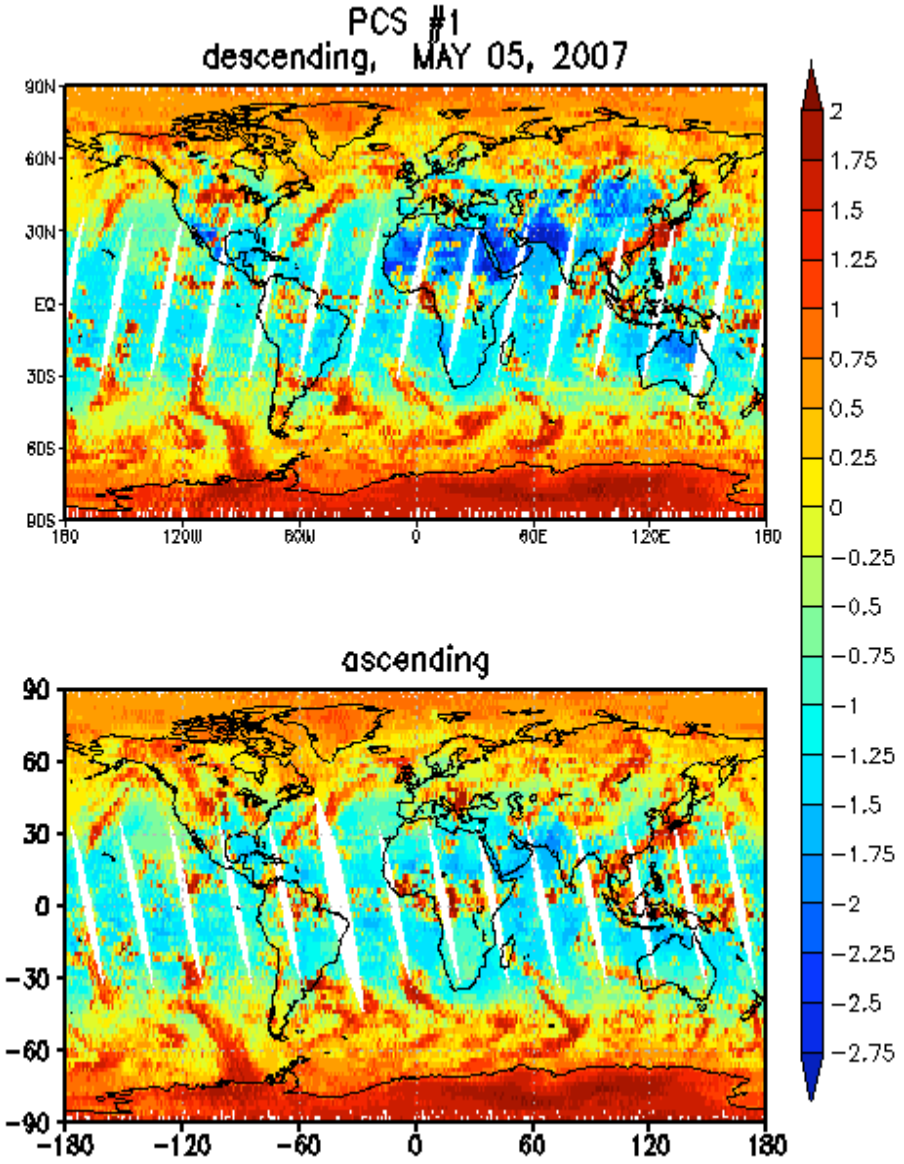

Eigenvectors #1–#25 (3–Band) 20070307
Eigenvector
Wavenumber
0
1
2
3
4
5
1000
1500
2000
2500

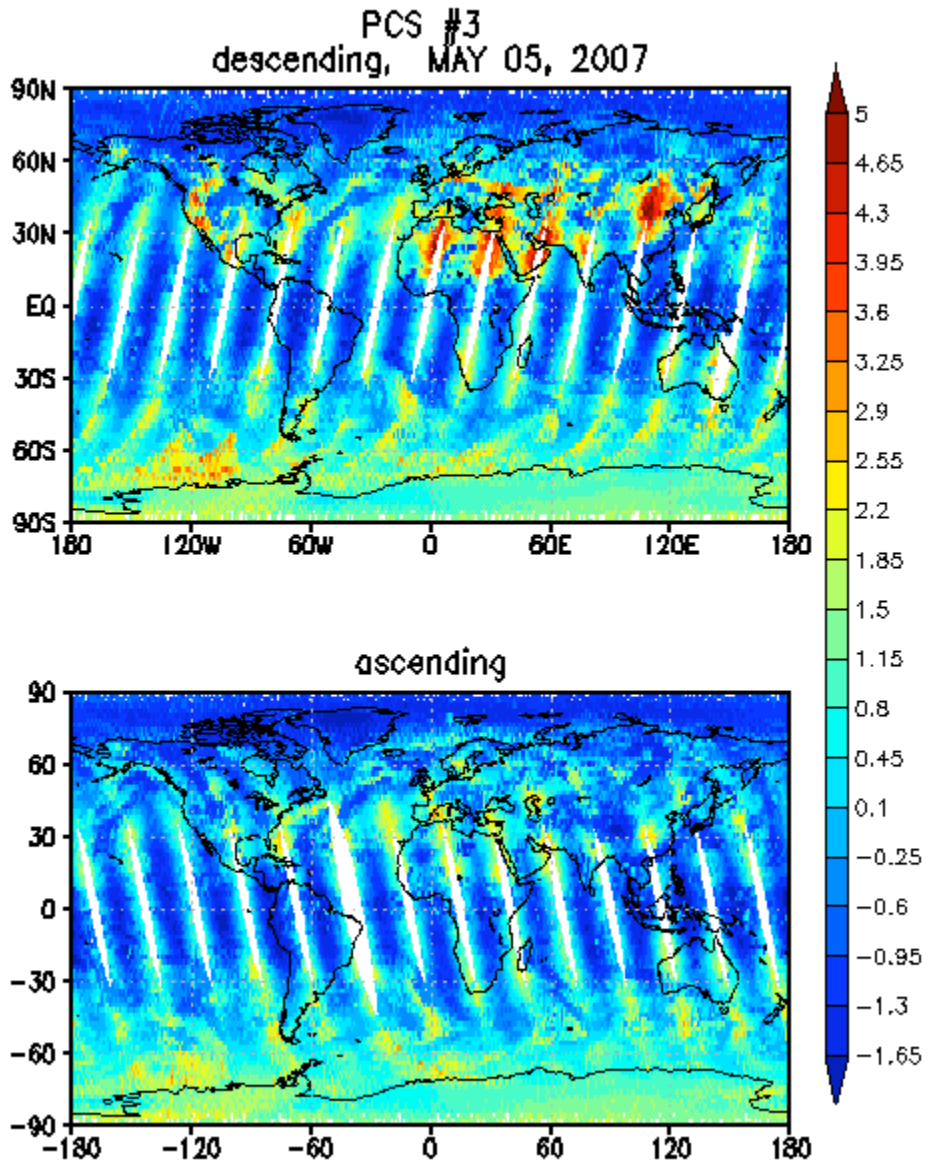

Band1 Eigenvalues of [R−<R>]W[R−<R>]T
IASI (20070804)
λ(k)
index number, k

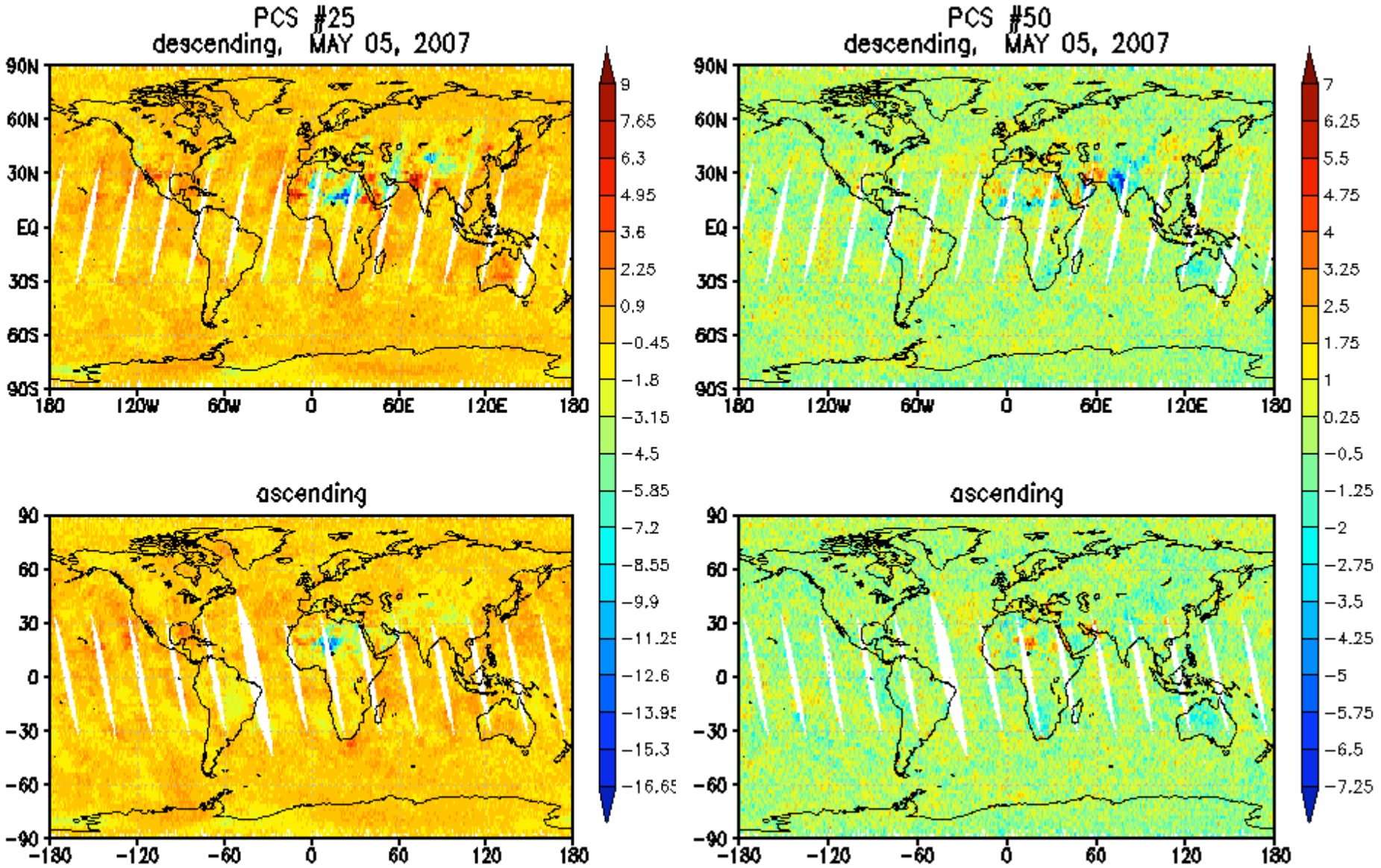

Band2 Eigenvalues of [R−<R>]W[R−<R>]T
IASI (20070804)
λ(k)
index number, k

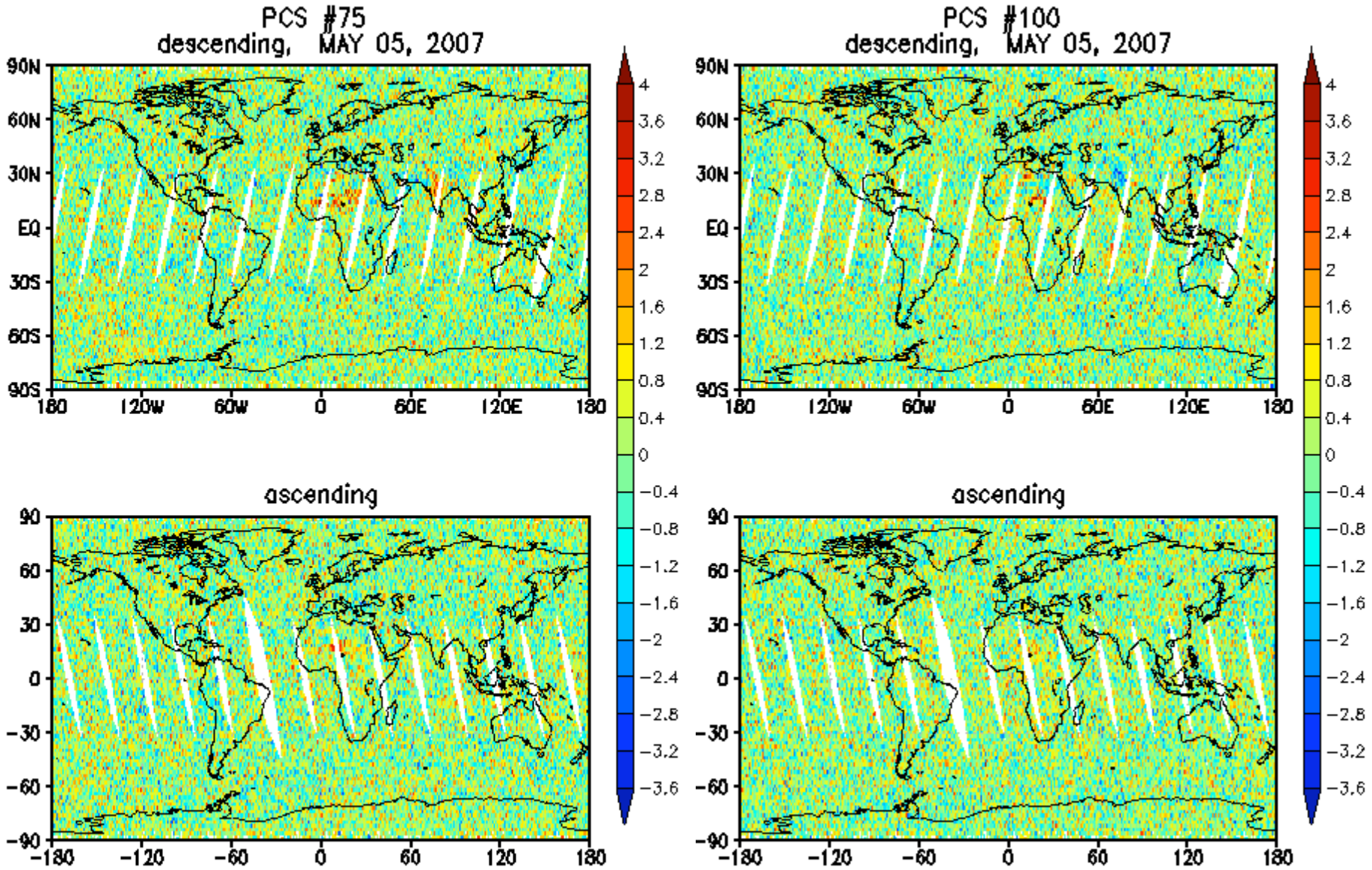

Band3 Eigenvalues of [R−<R>]W[R−<R>]T
IASI (20070804)
λ(k)
index number, k


Full−Band Eigenvalues of [R−<R>]W[R−<R>]T
IASI (20070804)
λ(k)
index number, k


PCS #1
descending, MAY 05, 2007
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
−0.25
−0.5
−0.75
−1
−1.25
−1.5
−1.75
−2
−2.25
−2.5
−2.75
ascending
90
60
30
0
−30
−60
−90
−180
−120
−60
0
60
120
180


PCS #3
descending, MAY 05, 2007
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
5
4.65
4.3
3.95
3.6
3.25
2.9
2.55
2.2
1.85
1.5
1.15
0.8
0.45
0.1
−0.25
−0.6
−0.95
−1.3
−1.65
ascending
90
60
30
0
−30
−60
−90
−180
−120
−60
0
60
120
180


PCS #25
descending, MAY 05, 2007
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
ascending
90
60
30
0
-30
-60
-90
-180
-120
-60
0
60
120
180
9
7.65
6.3
4.95
3.6
2.25
0.9
-0.45
-1.8
-3.15
-4.5
-5.85
-7.2
-8.55
-9.9
-11.25
-12.6
-13.95
-15.3
-16.65
PCS #50
descending, MAY 05, 2007
ascending
7
6.25
5.5
4.75
4
3.25
2.5
1.75
1
0.25
-0.5
-1.25
-2
-2.75
-3.5
-4.25
-5
-5.75
-6.5
-7.25


PCS #75
descending, MAY 05, 2007
PCS #100
descending, MAY 05, 2007
ascending
ascending
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
90
60
30
0
-30
-60
-90
-180
-120
-60
0
60
120
180
4
3.6
3.2
2.8
2.4
2
1.6
1.2
0.8
0.4
0
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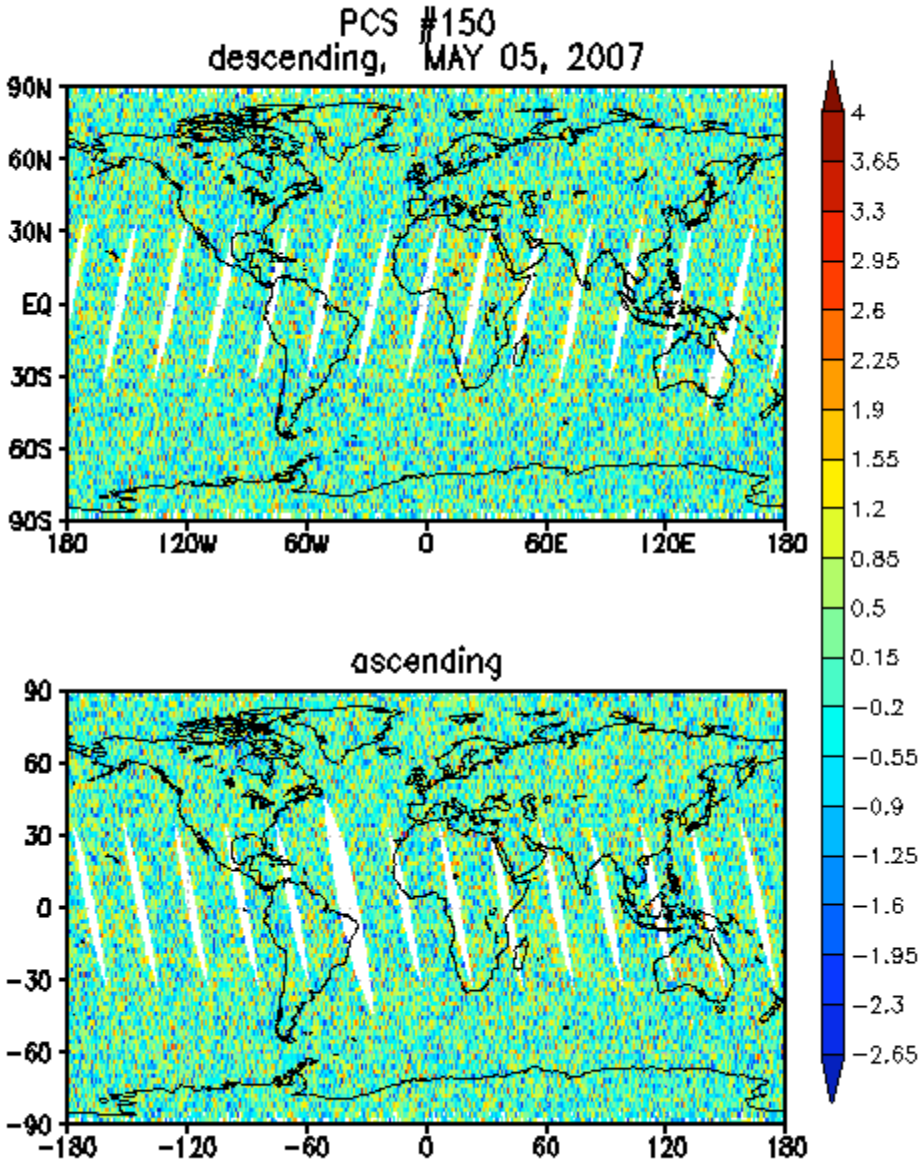
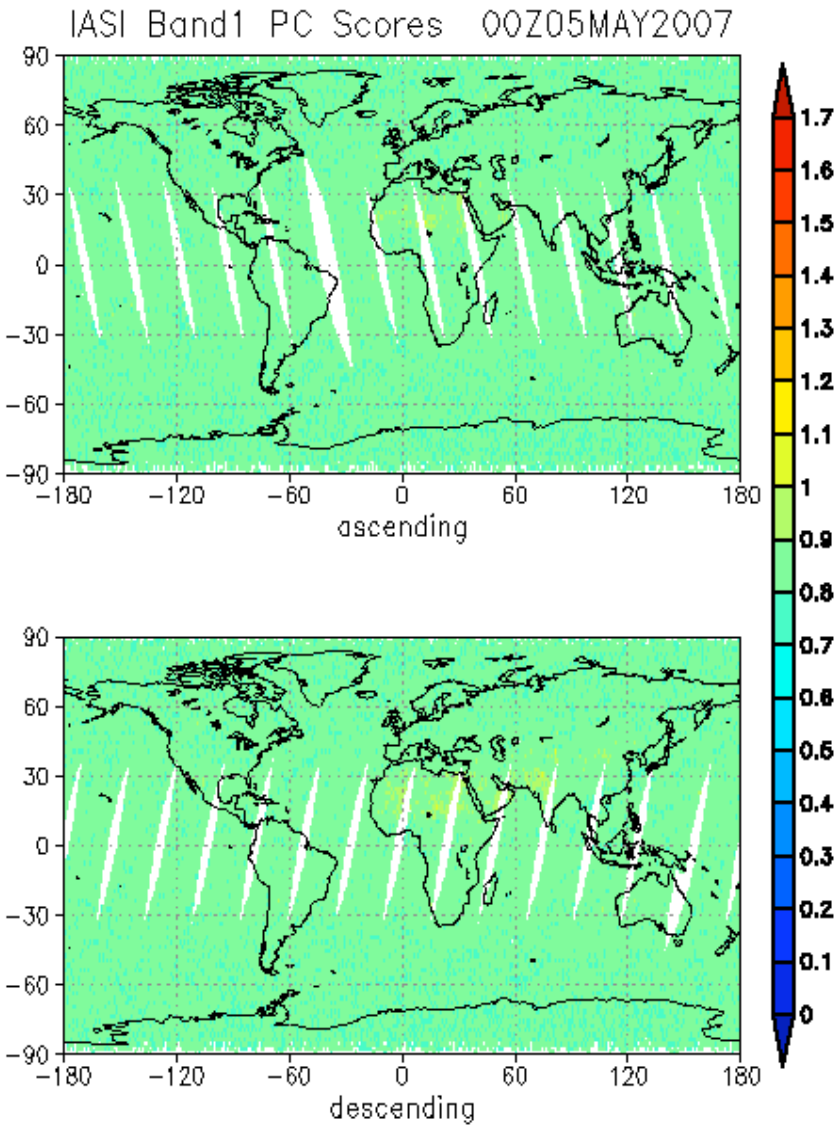
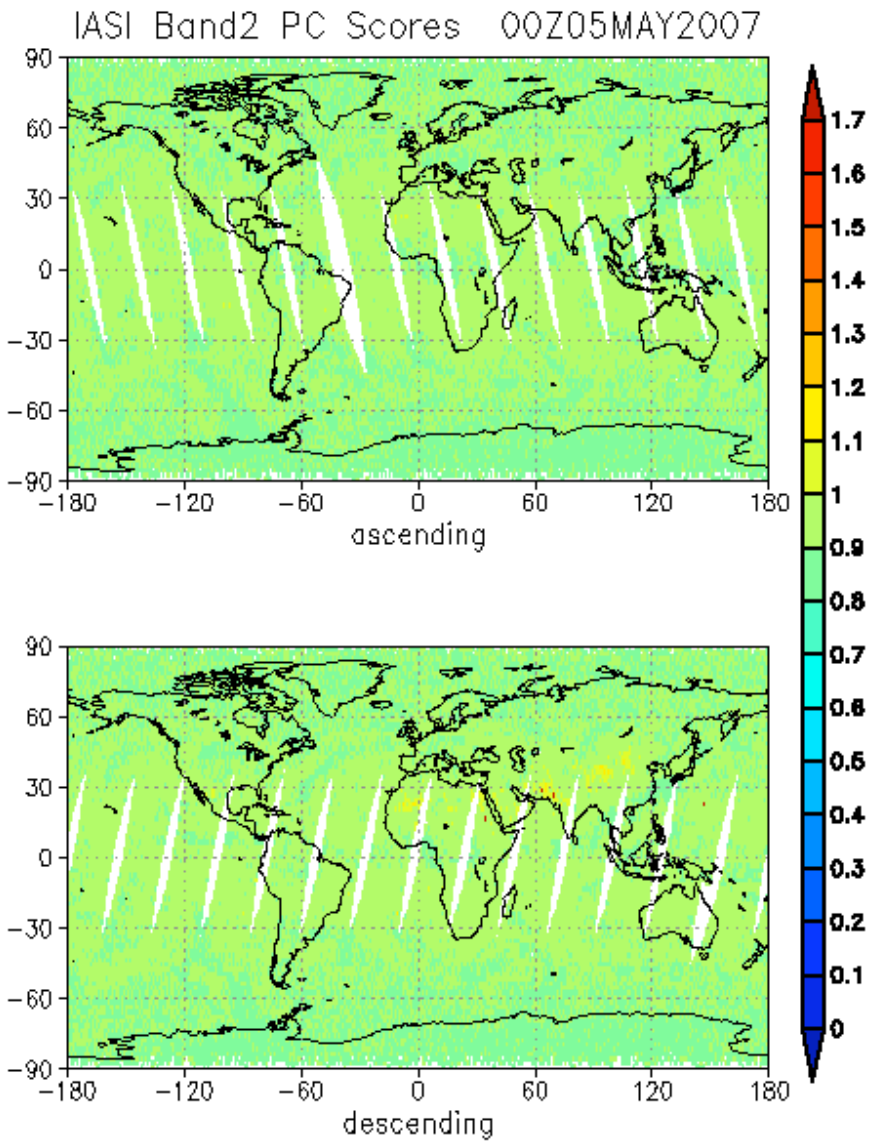
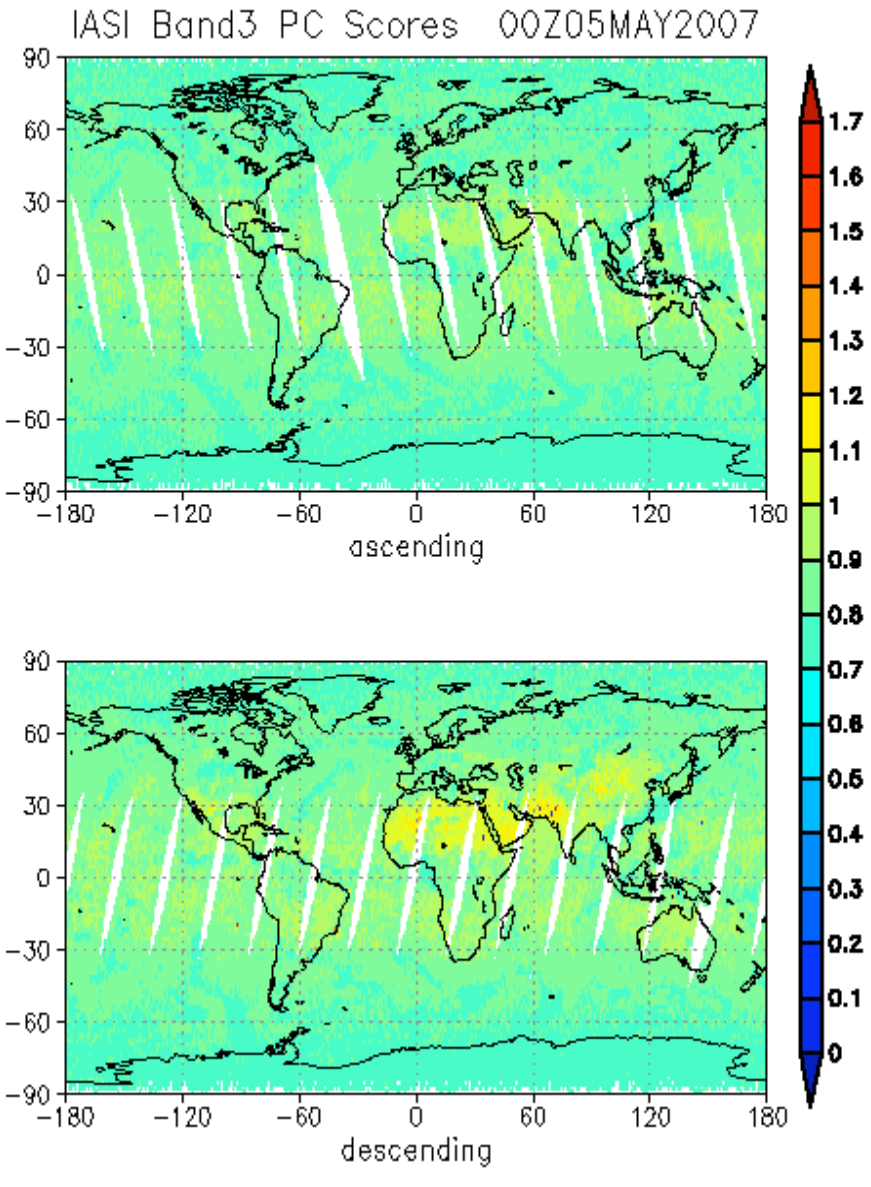
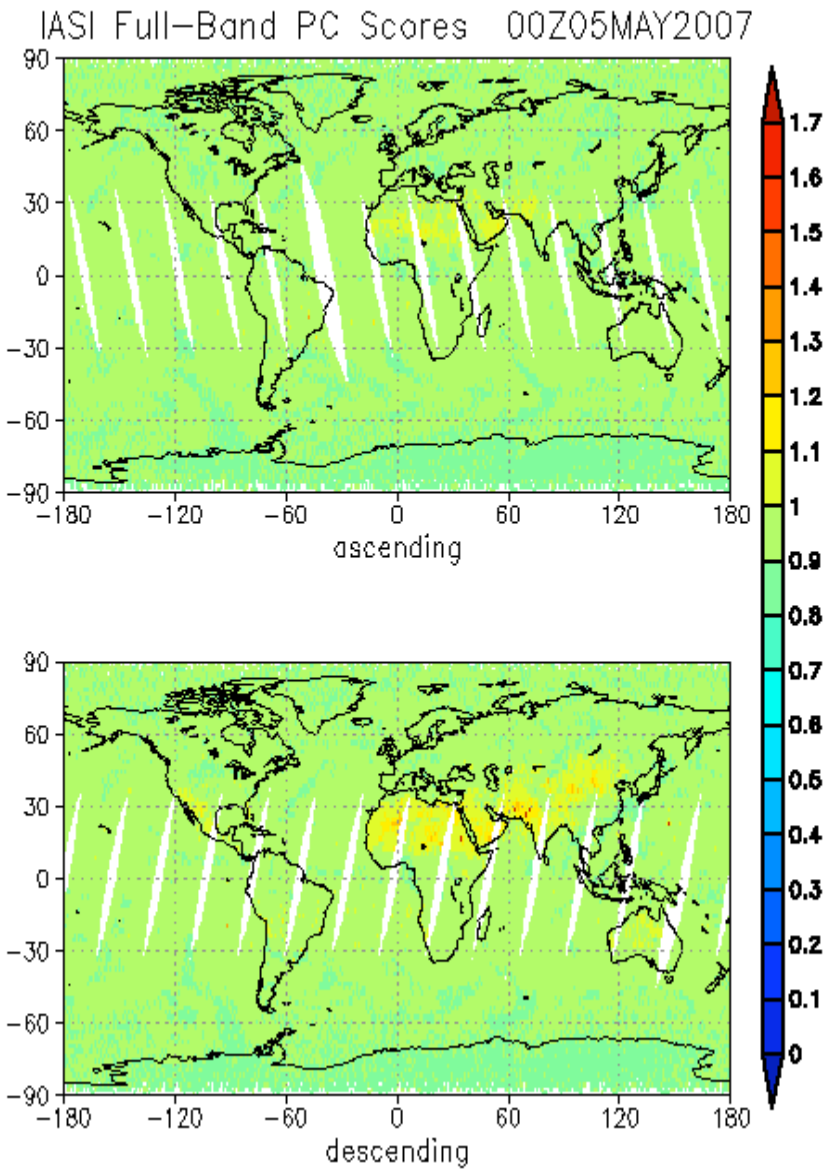
-1.2
-1.6
-2
-2.4
-2.8
-3.2
-3.6

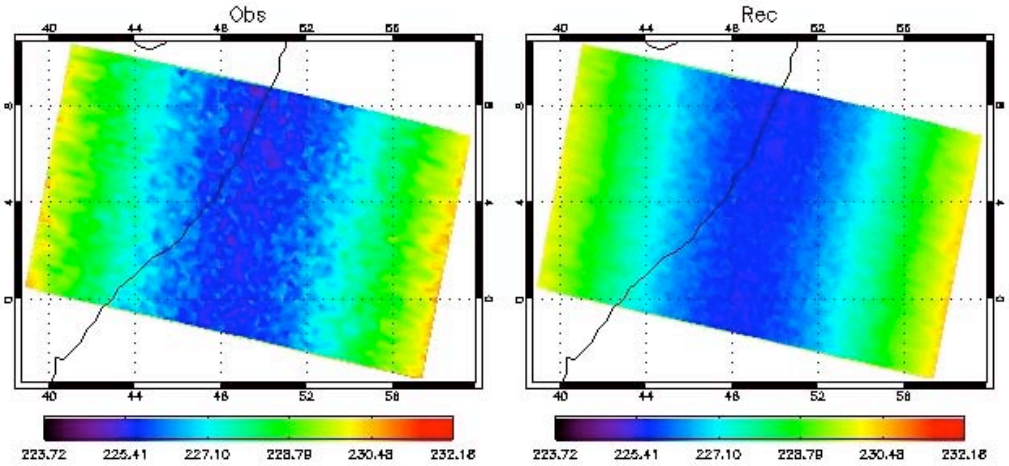

PCS #150
descending, MAY 05, 2007
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
ascending
90
60
30
0
-30
-60
-90
-180
-120
-60
0
60
120
180
4
3.65
3.3
2.95
2.6
2.25
1.9
1.55
1.2
0.85
0.5
0.15
-0.2
-0.55
-0.9
-1.25
-1.6
-1.95
-2.3
-2.65

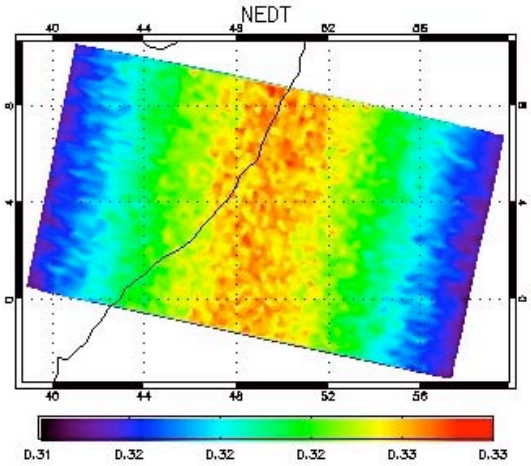

IASI Band1 PC Scores 00Z05MAY2007
90
60
30
0
−30
−60
−90
−180
−120
−60
0
60
120
180
ascending
descending
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

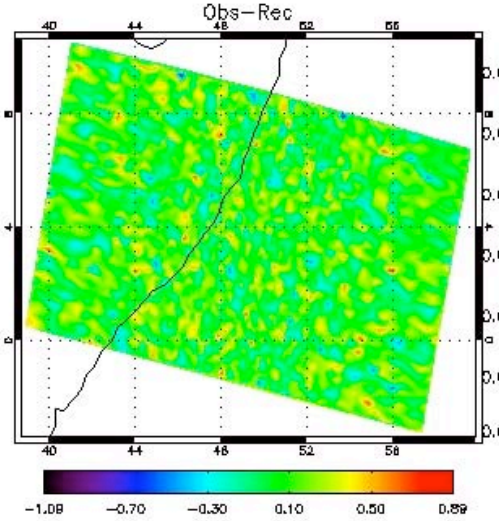

IASI Band2 PC Scores 00Z05MAY2007
90
60
30
0
−30
−60
−90
−180
−120
−60
0
60
120
180
ascending
descending
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

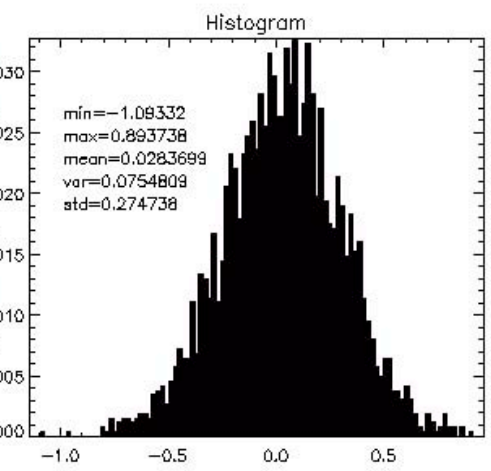

IASI Band3 PC Scores 00Z05MAY2007
90
60
30
0
−30
−60
−90
−180
−120
−60
0
60
120
180
ascending
descending
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

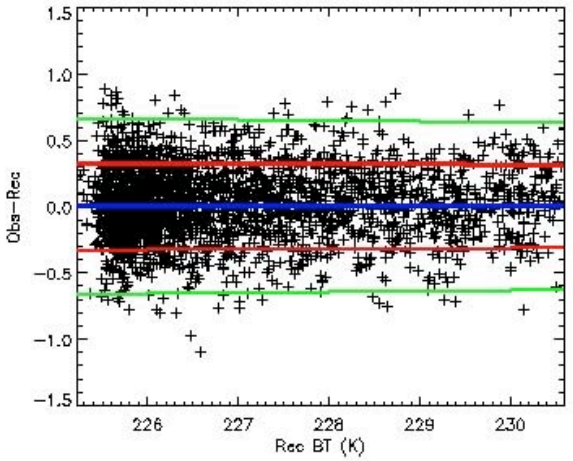

IASI Full−Band PC Scores 00Z05MAY2007
90
60
30
0
−30
−60
−90
−180
−120
−60
0
60
120
180
ascending
descending
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0





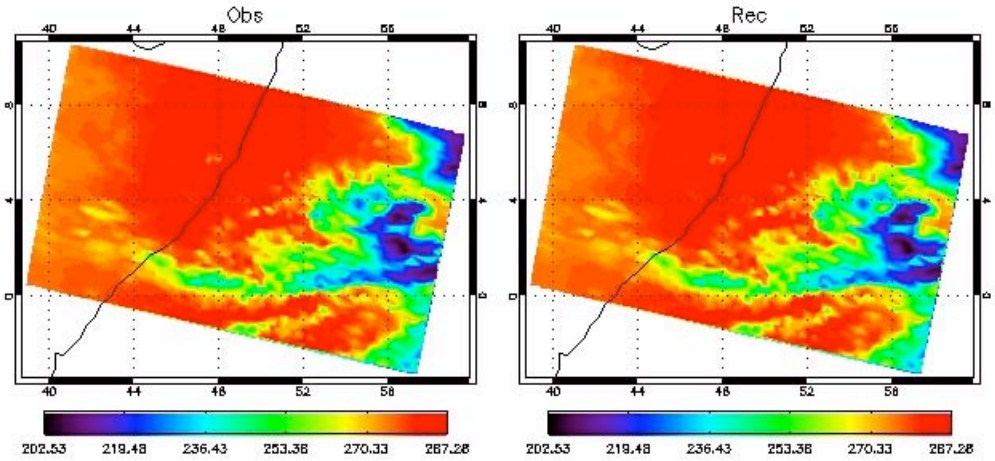


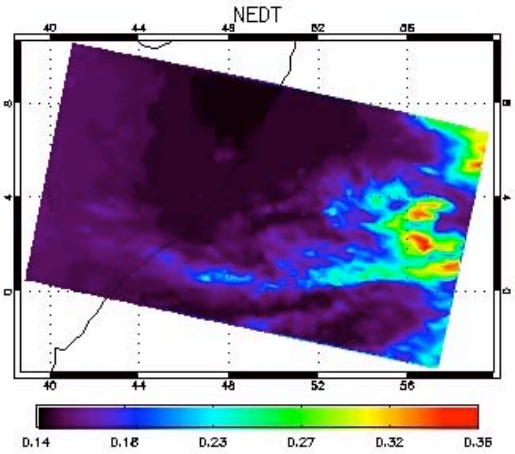


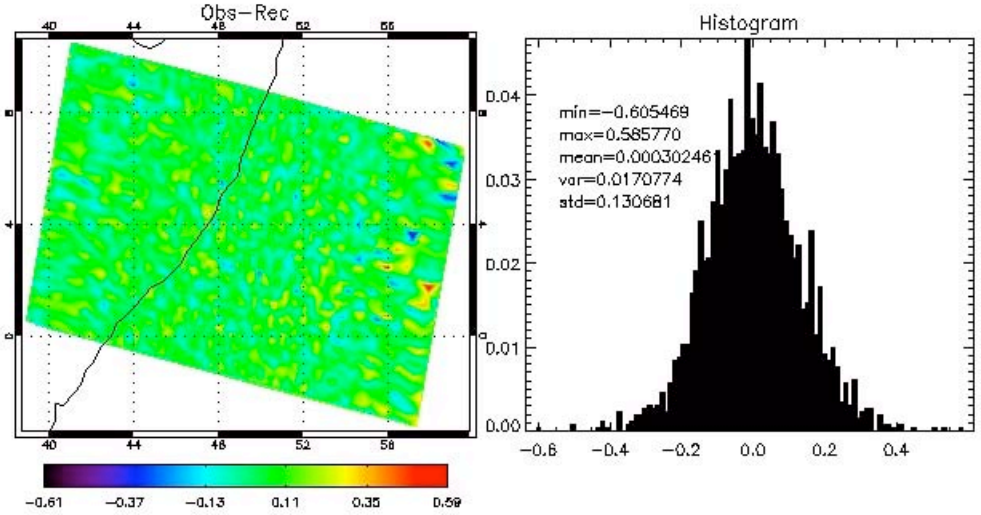


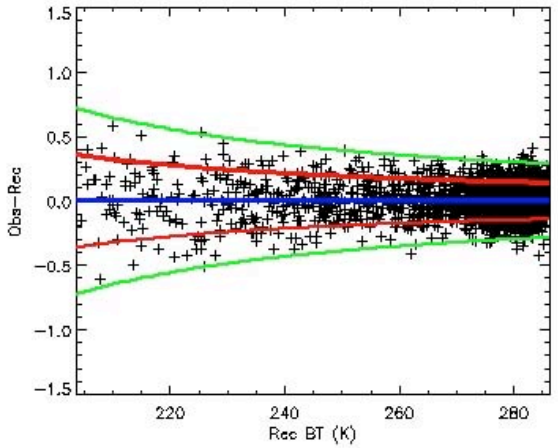
IASI [670.000cm−1] Granule−125 20070910

IASI [670.000cm−1] Granule−125 20070910



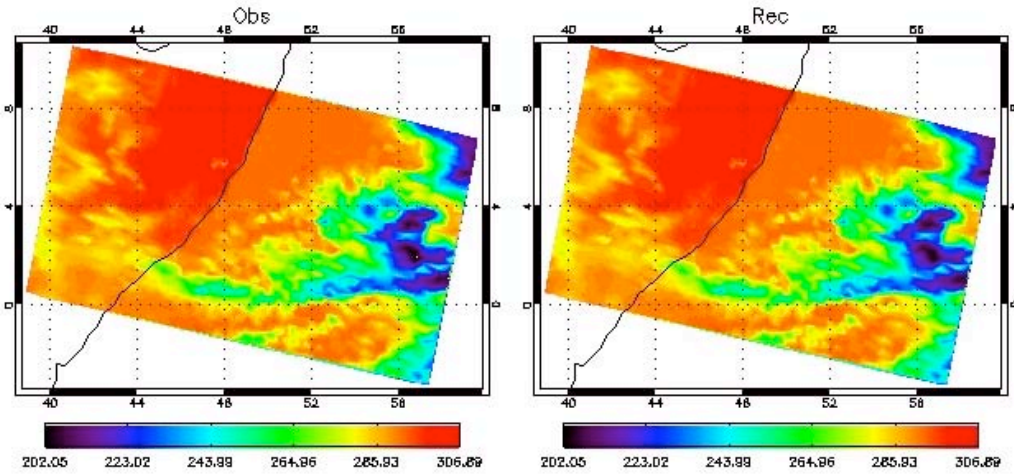


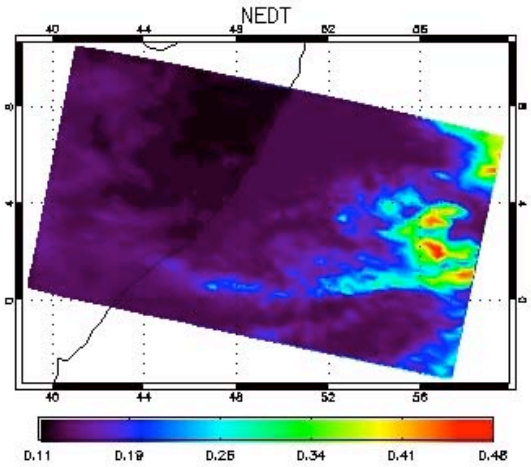


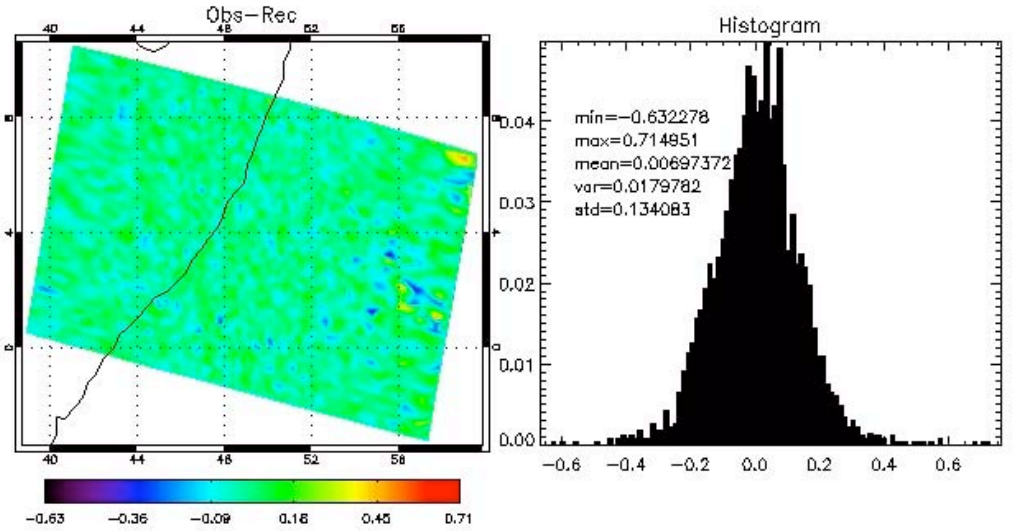


IASI [770.000cm−1] Granule−125 20070910

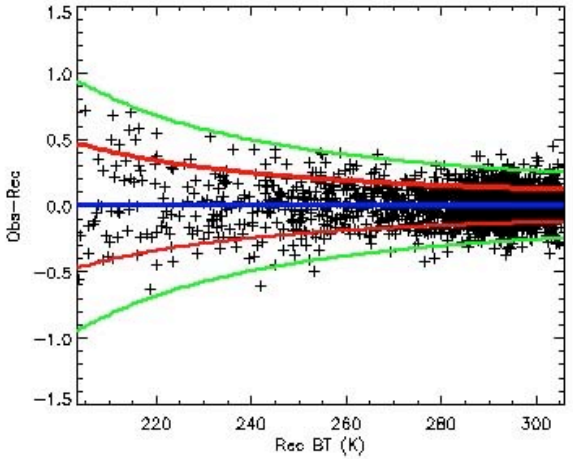
IASI [770.000cm−1] Granule−125 20070910



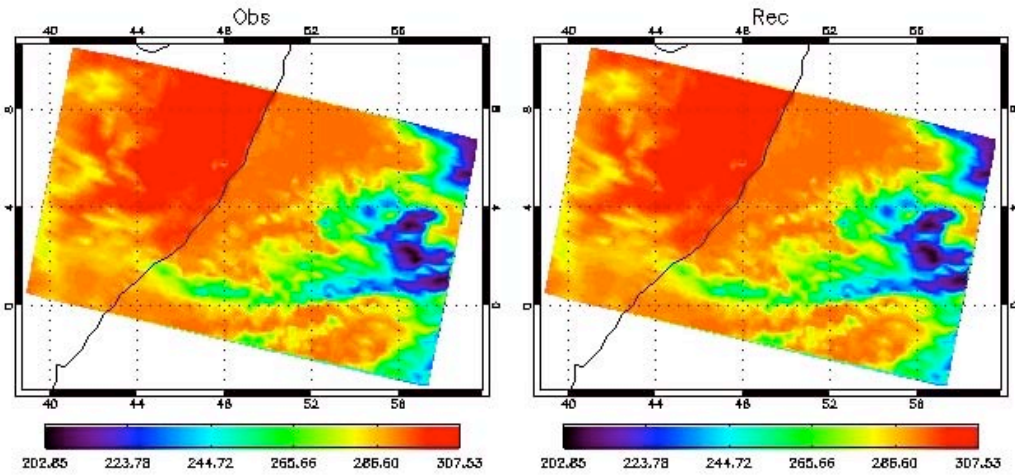


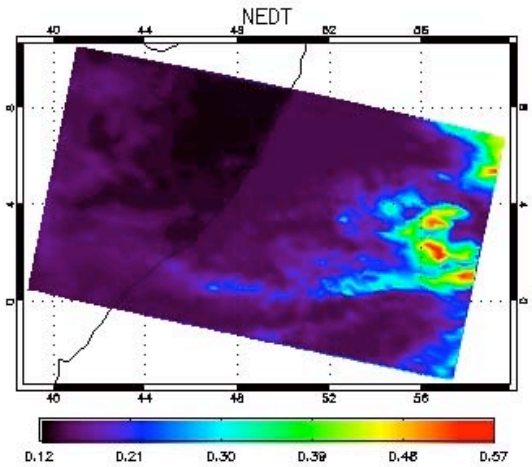


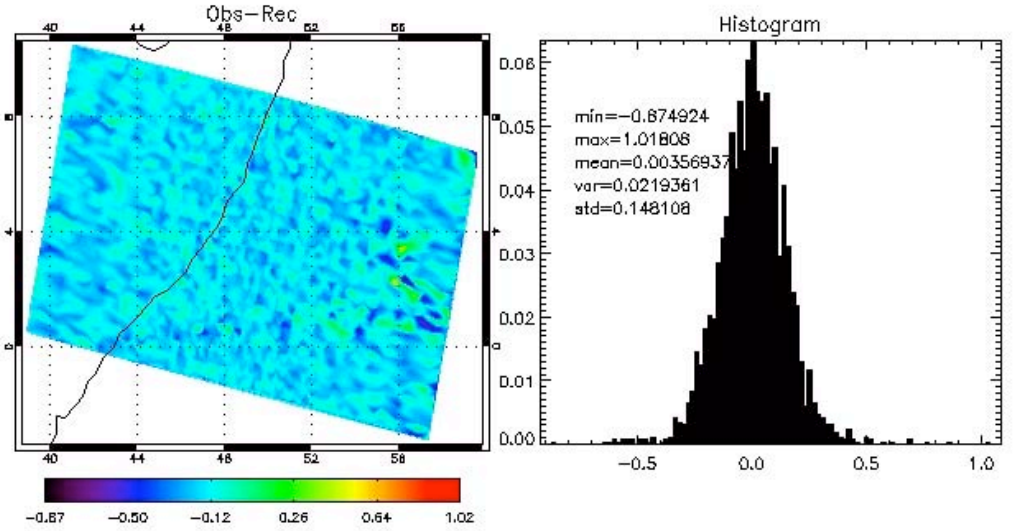
IASI [900.000cm−1] Granule−125 20070910



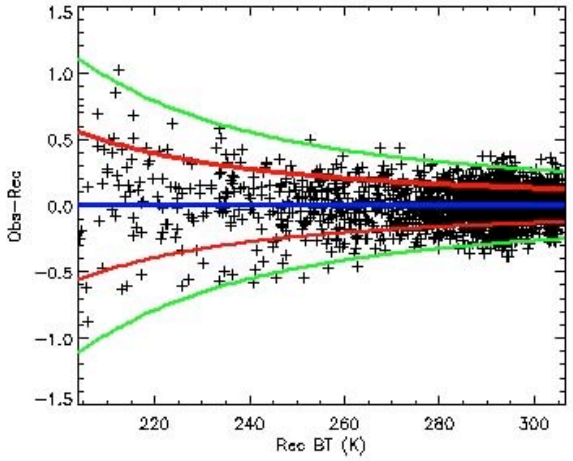
IASI [900.000cm−1] Granule−125 20070910



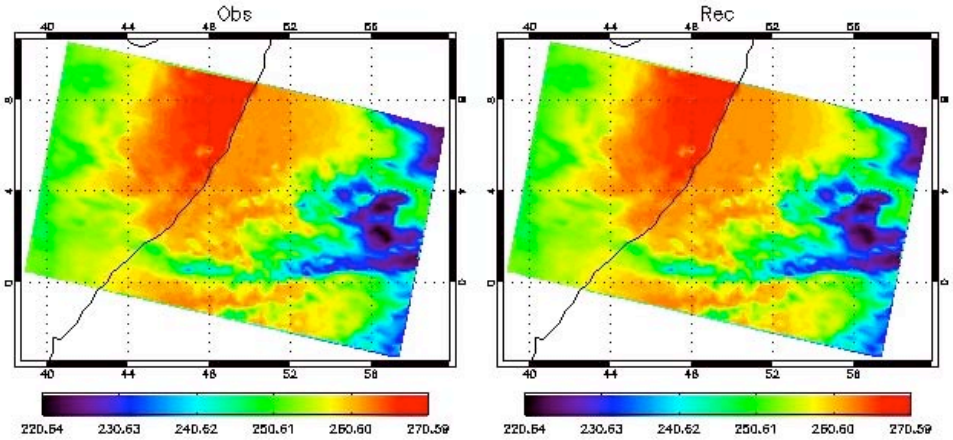


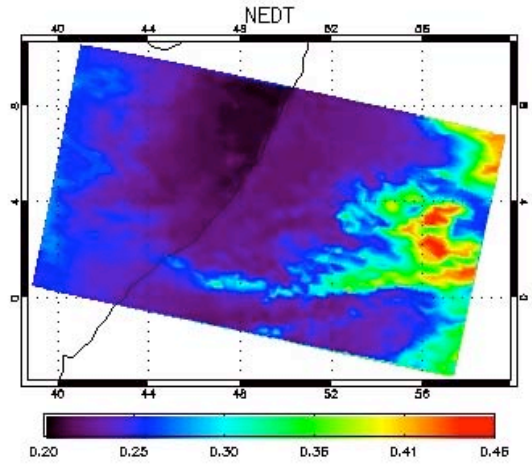


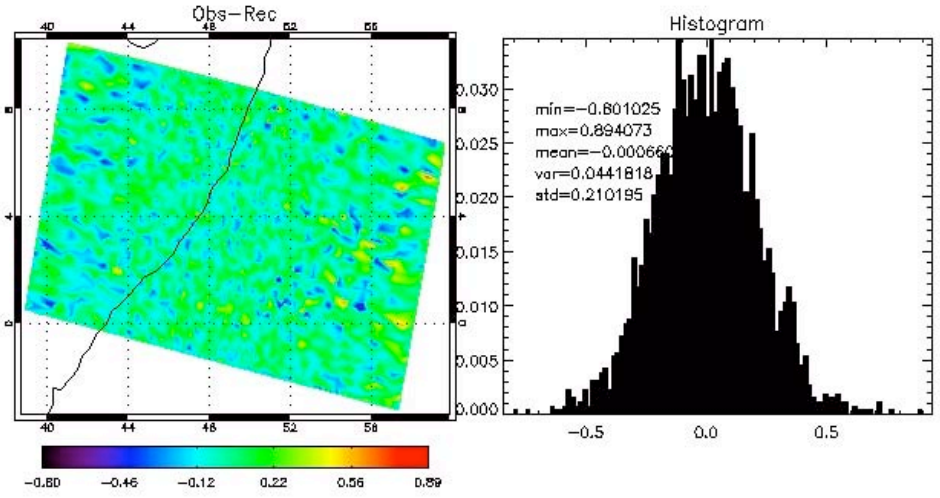
IASI [965.000cm−1] Granule−125 20070910

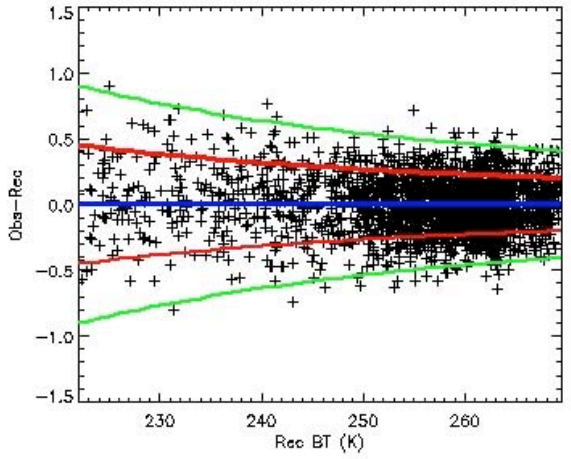


IASI [965.000cm−1] Granule−125 20070910



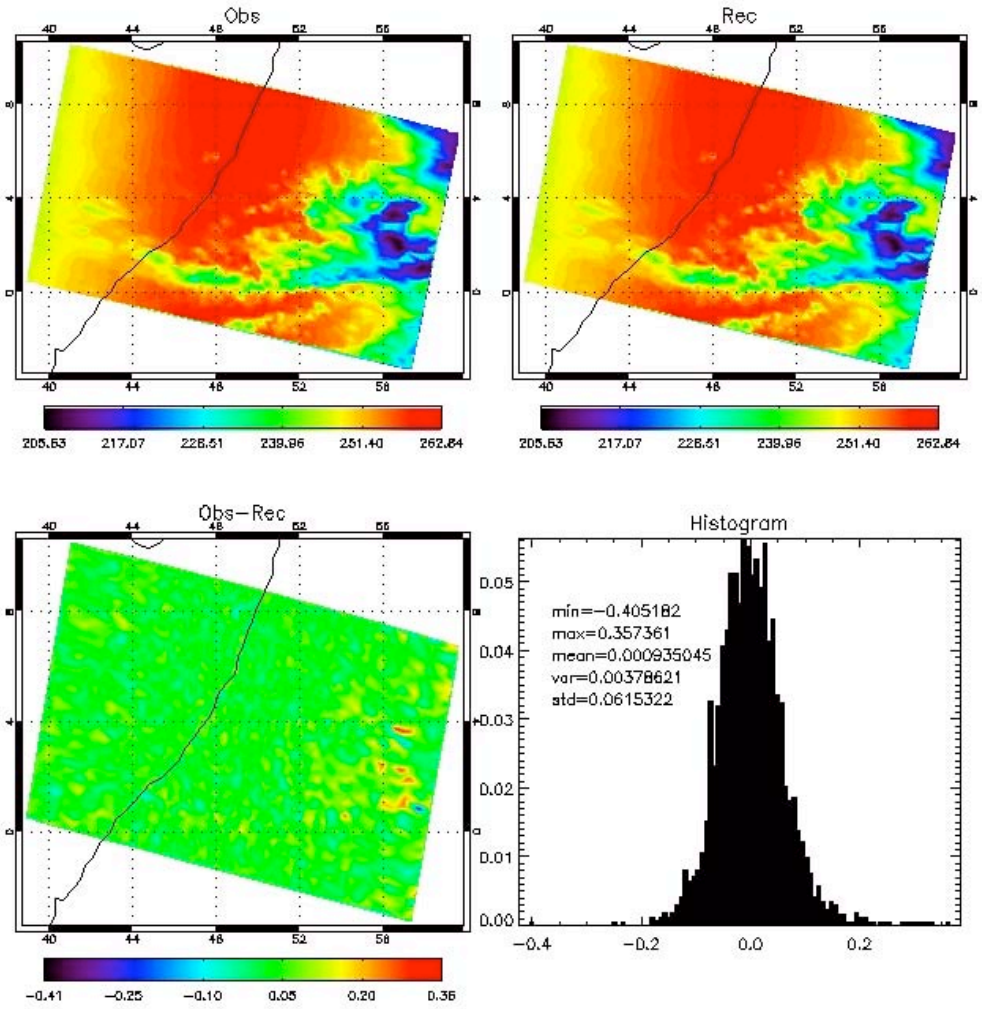




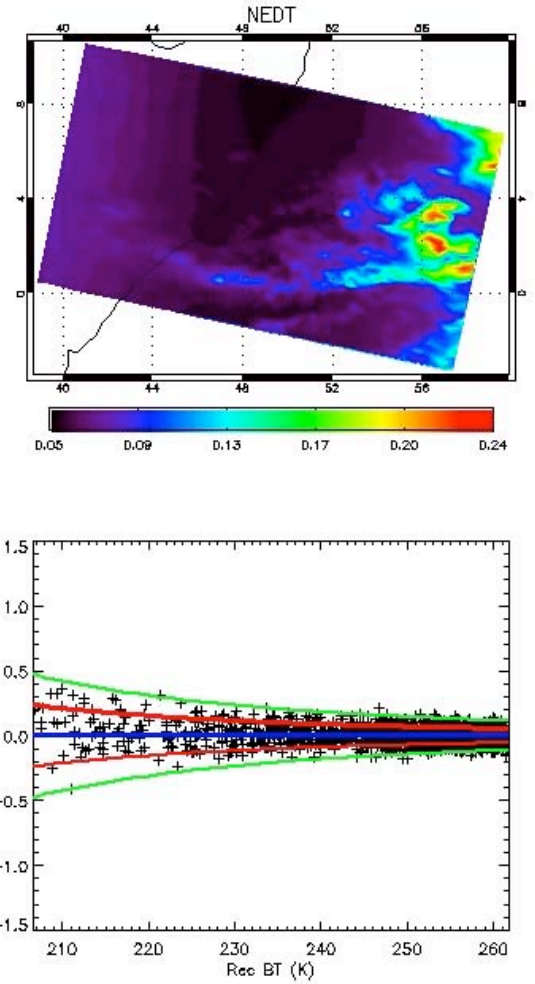


IASI [1041.50cm-1] Granule-125 20070910

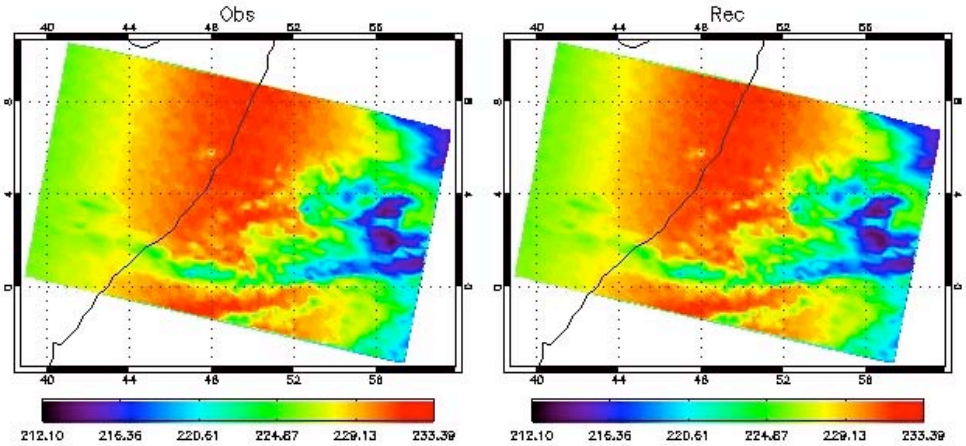
IASI [1041.50cm-1] Granule-125 20070910

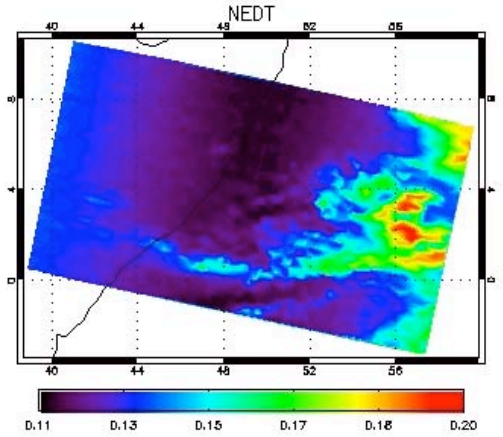


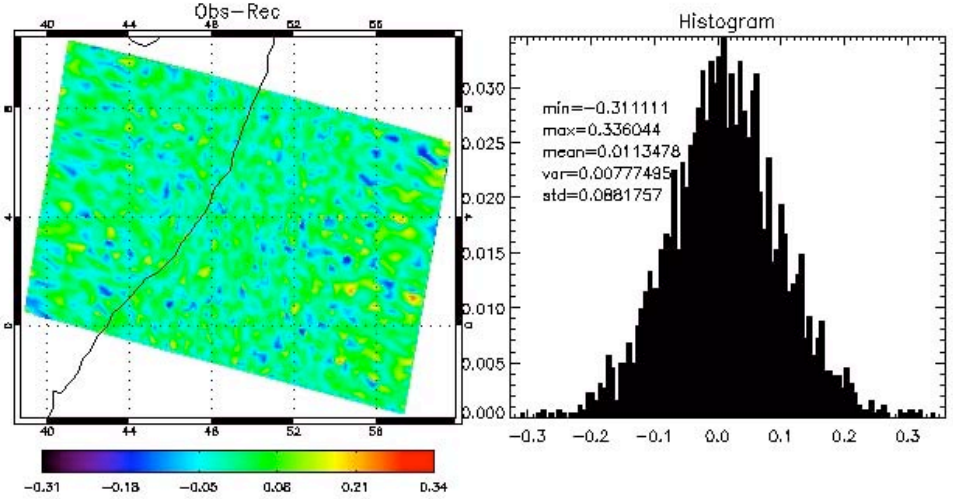
IASI [1298.00cm−1] Granule−125 20070910



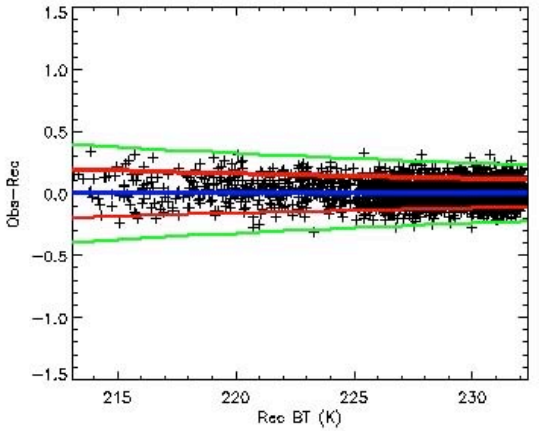
IASI [1298.00cm−1] Granule−125 20070910



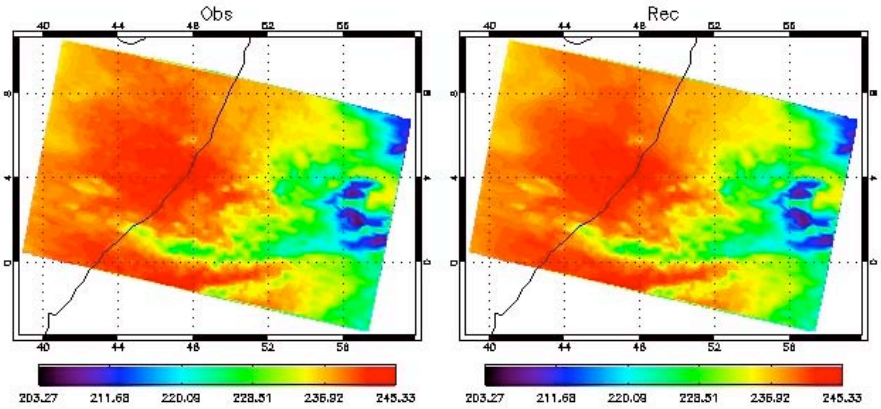


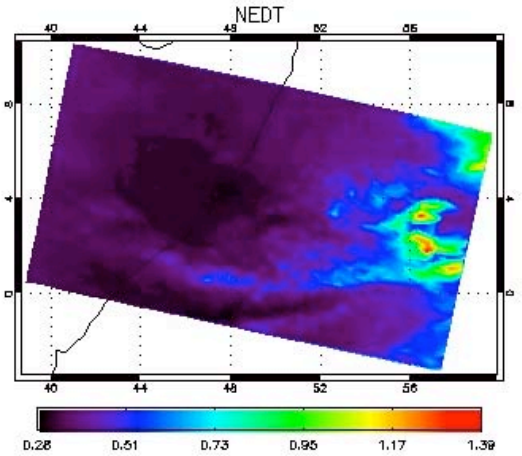


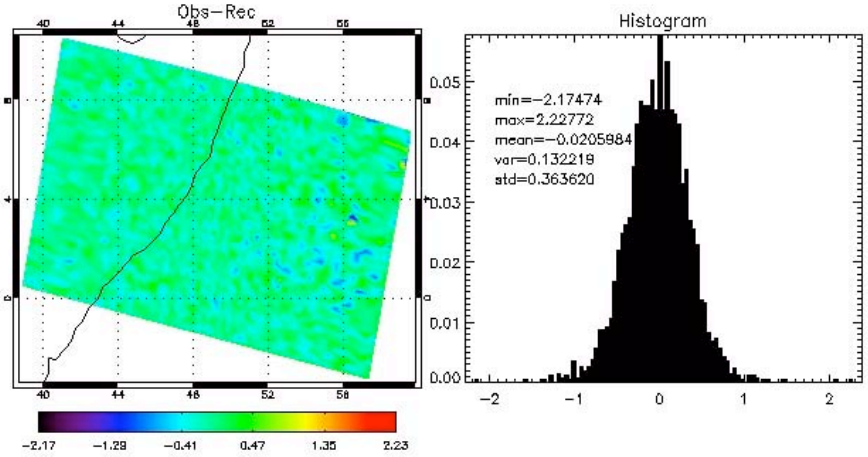
IASI [1306.25cm−1] Granule−125 20070910



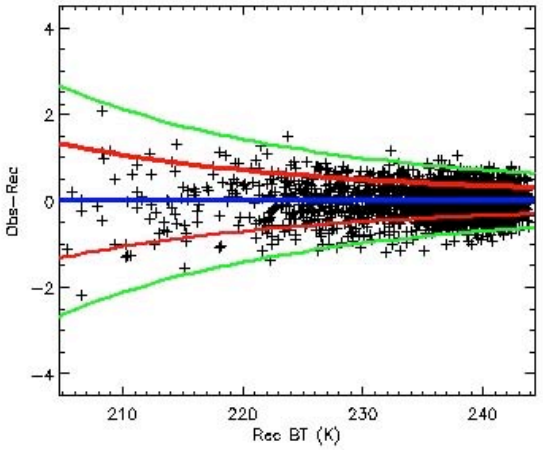
IASI [1306.25cm−1] Granule−125 20070910



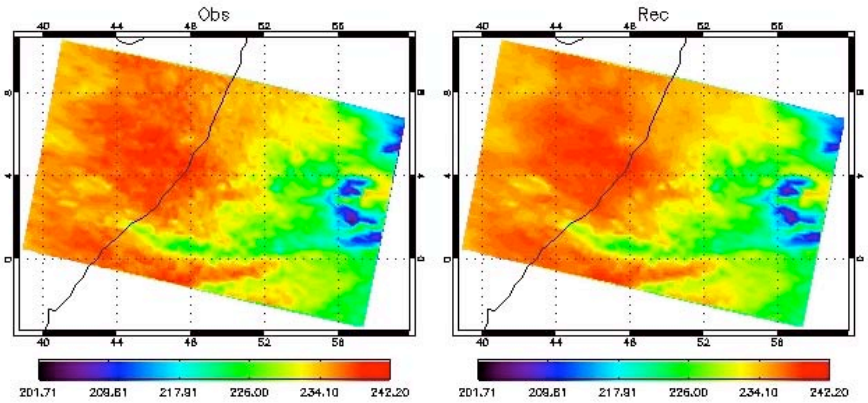


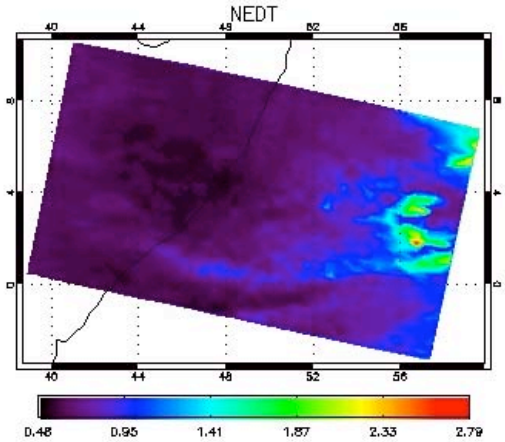


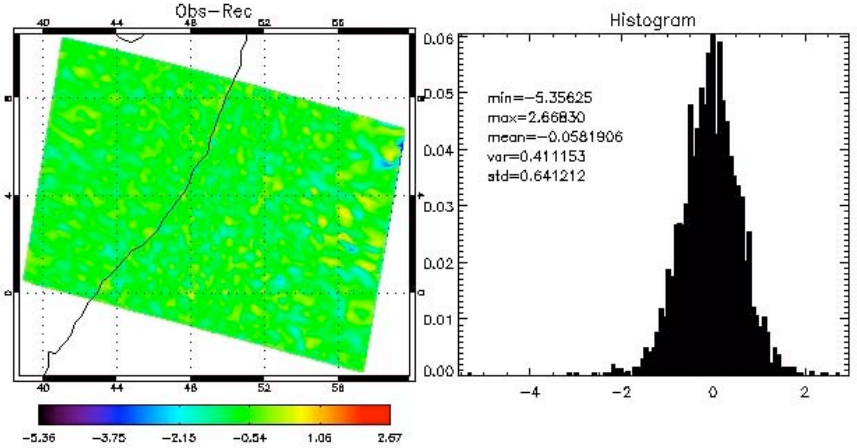
IASI [1594.75cm−1] Granule−125 20070910

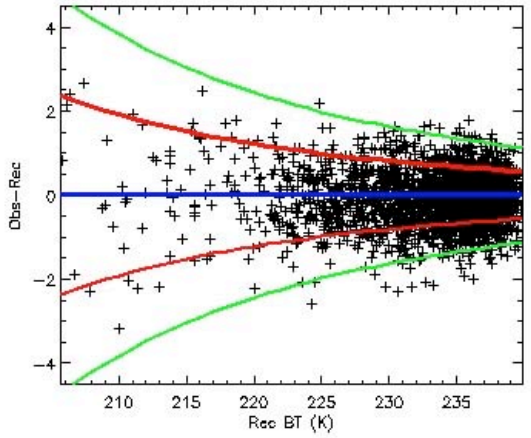


IASI [1594.75cm−1] Granule−125 20070910



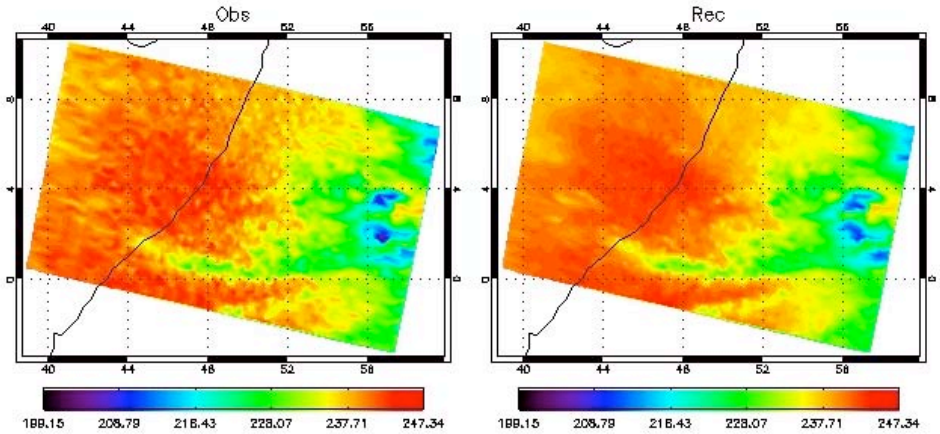


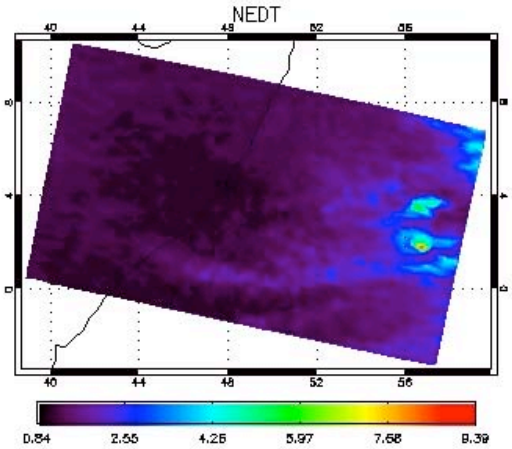


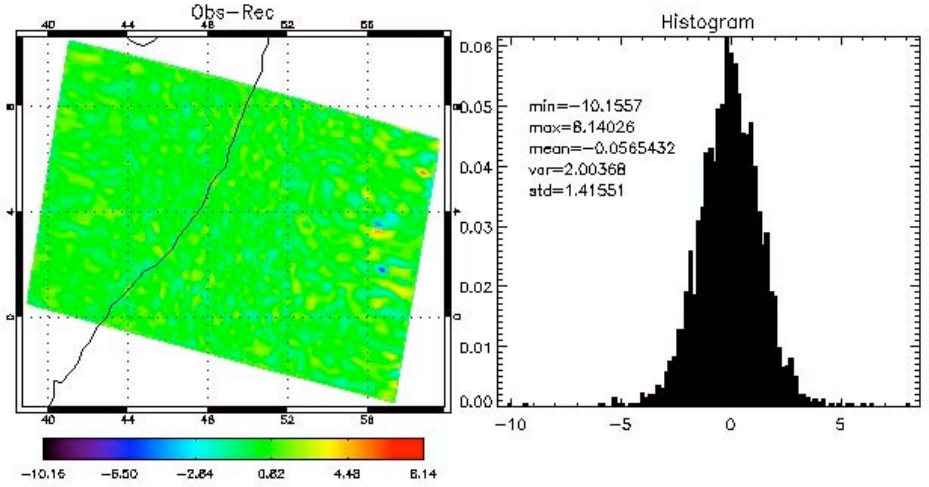


IASI [1739.00cm−1] Granule−125 20070910

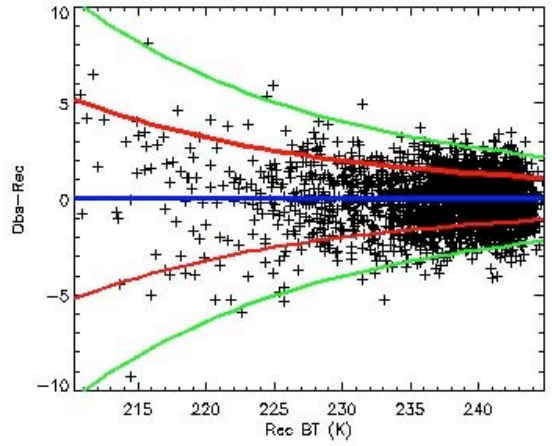
IASI [1739.00cm−1] Granule−125 20070910



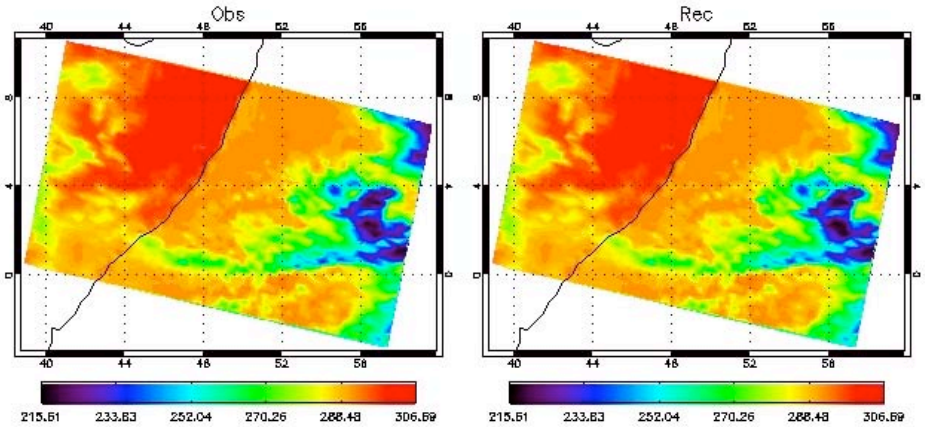


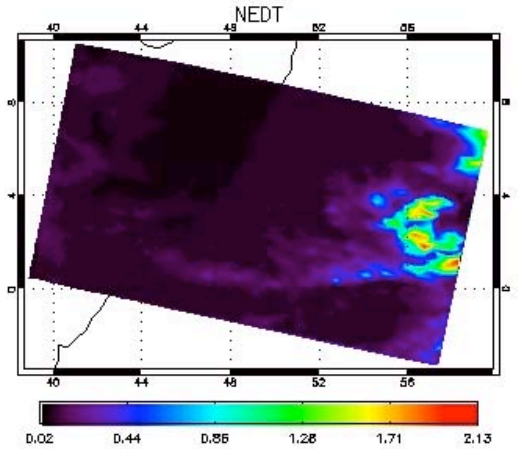


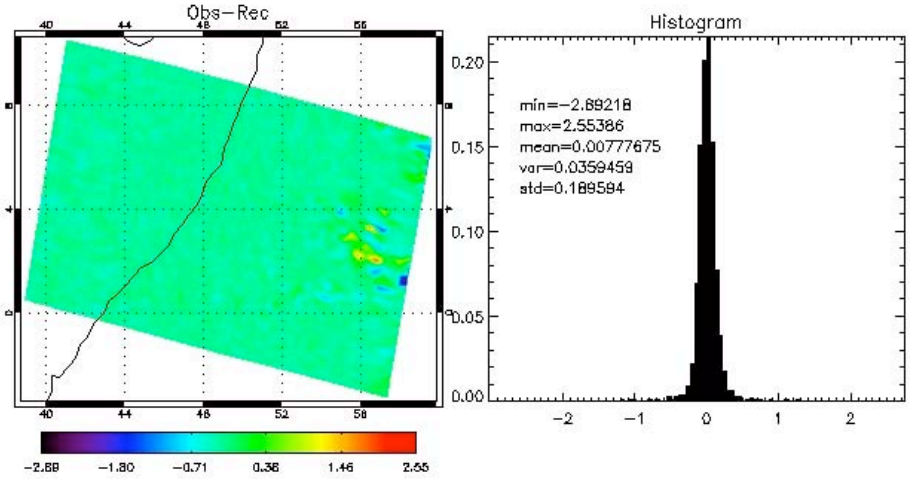
IASI [1923.00cm−1] Granule−125 20070910



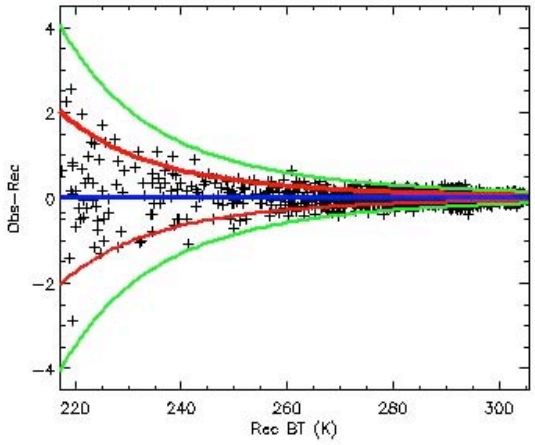
IASI [1923.00cm−1] Granule−125 20070910



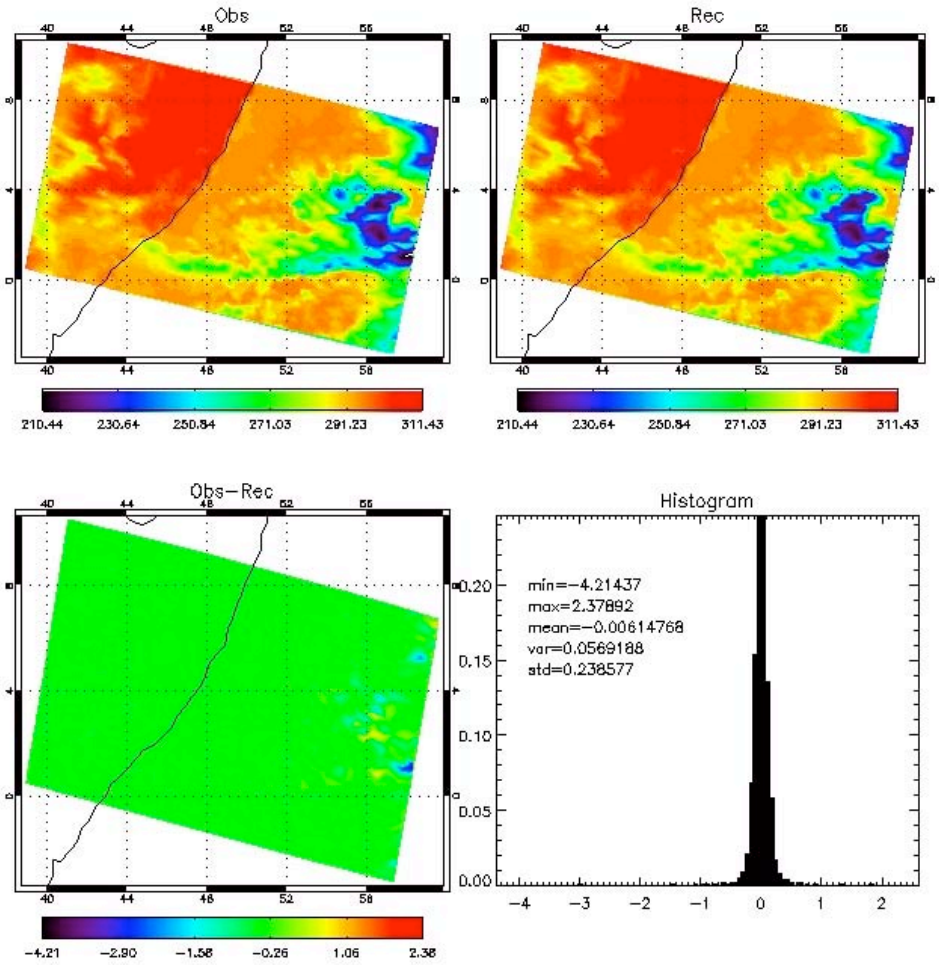




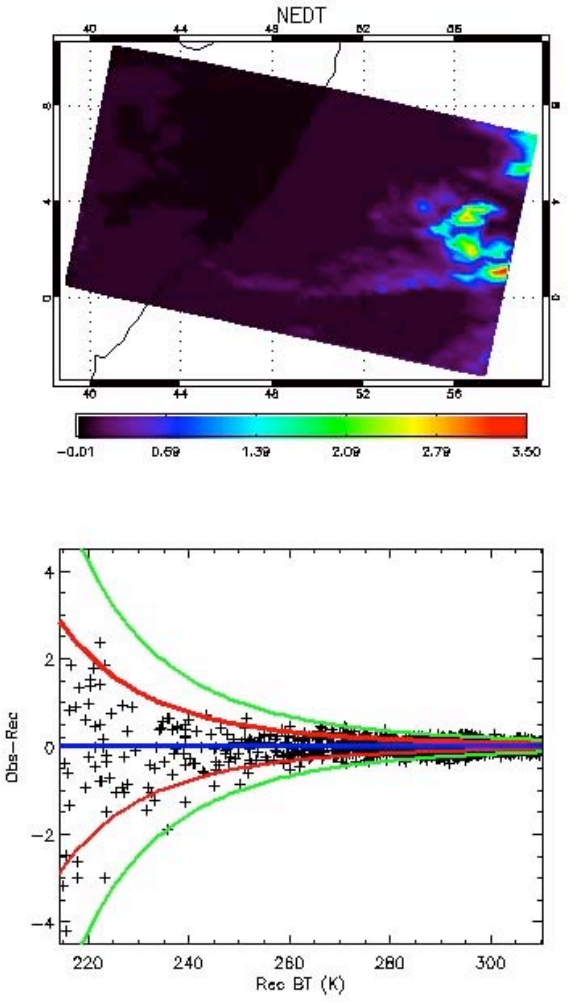
IASI [2105cm−1] Granule−125 20070910



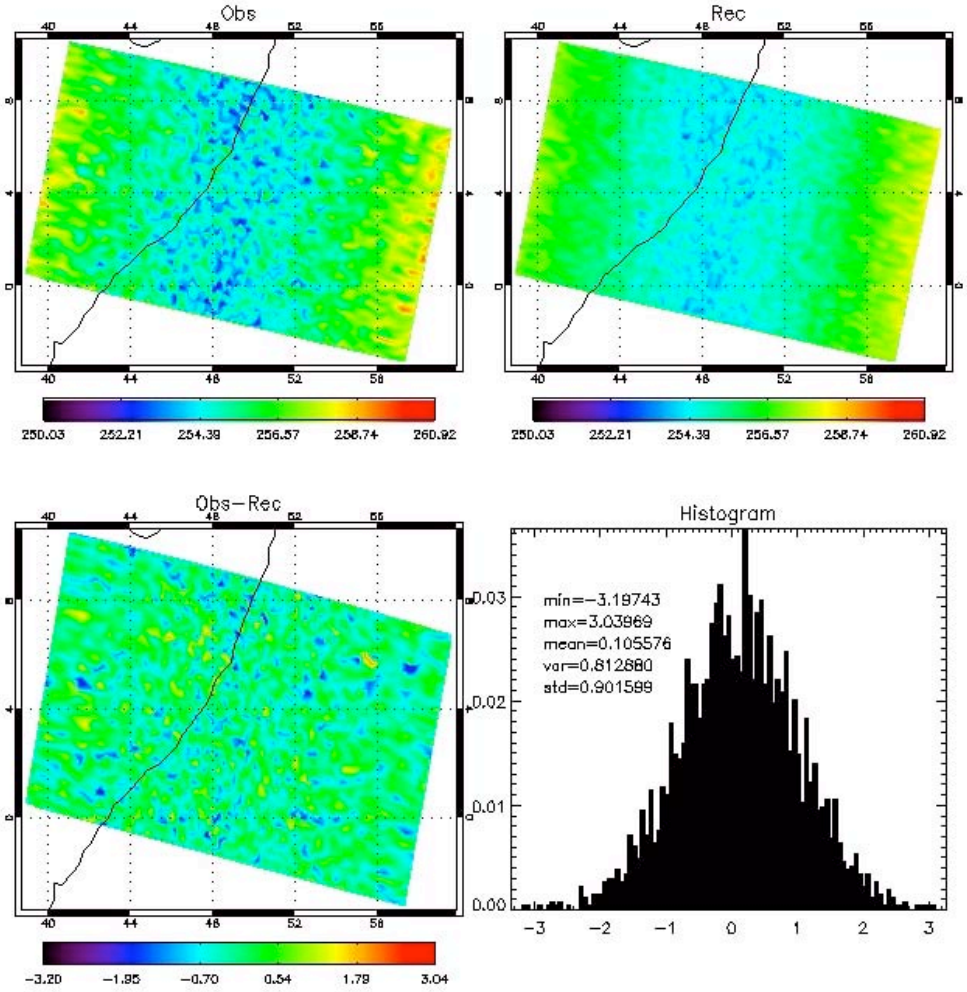
IASI [2105cm−1] Granule−125 20070910



IASI [2141cm−1] Granule−125 20070910

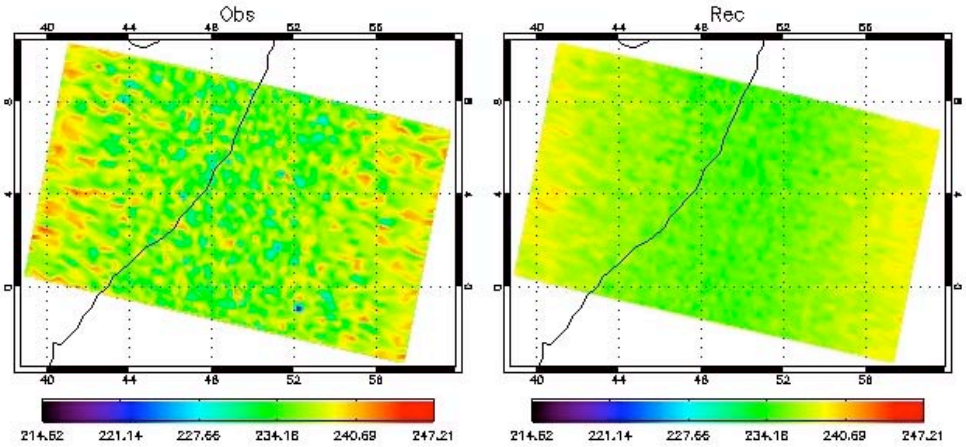


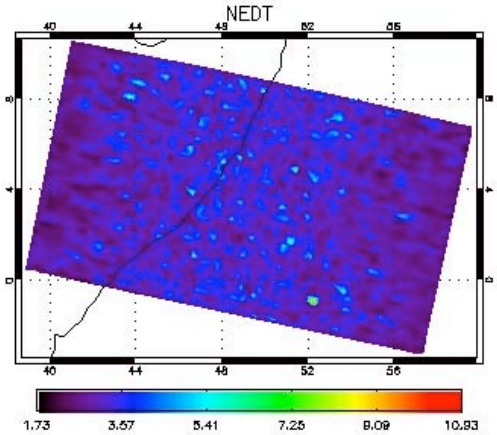
IASI [2141cm−1] Granule−125 20070910

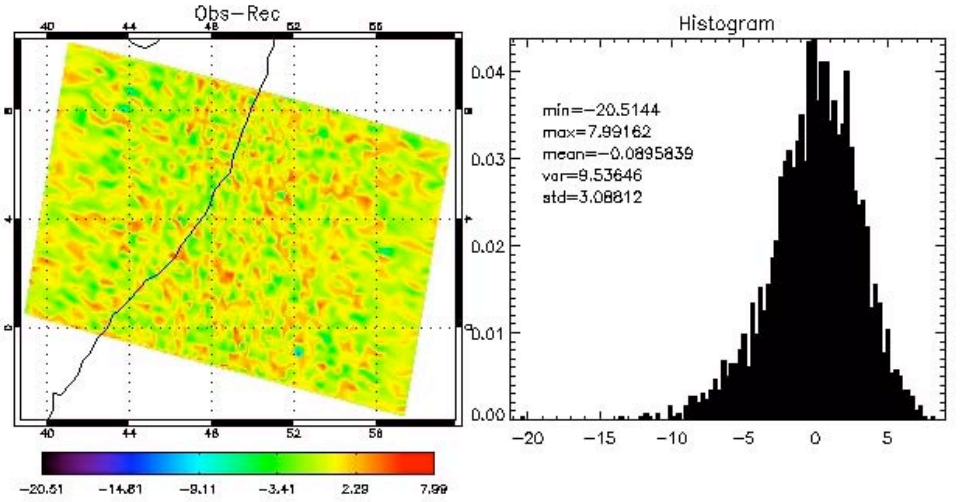


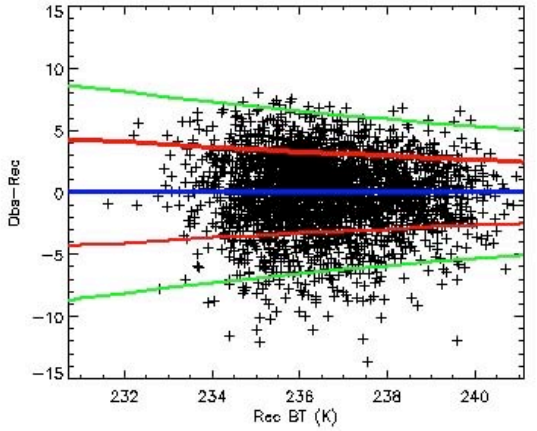
IASI [2325cm−1] Granule−125 20070910

IASI [2325cm−1] Granule−125 20070910



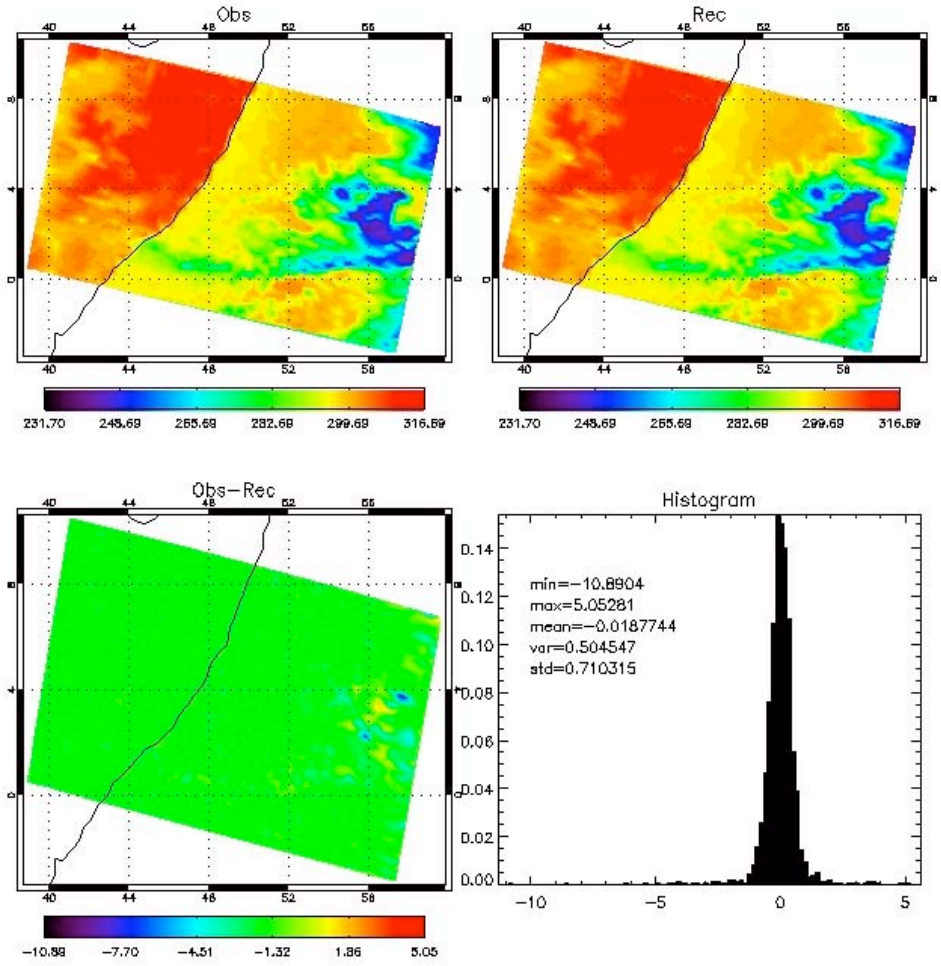




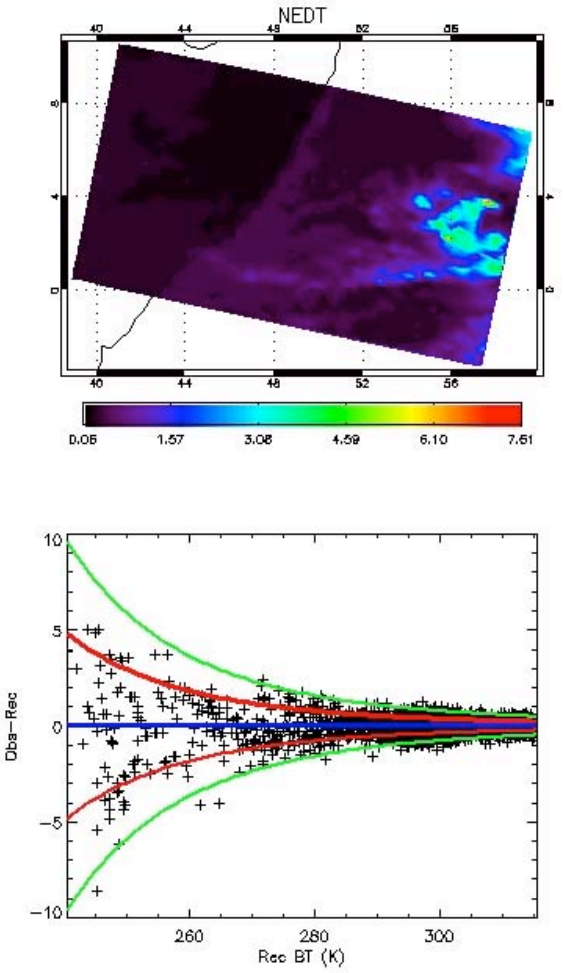


IASI [2375cm−1] Granule−125 20070910

IASI [2375cm−1] Granule−125 20070910



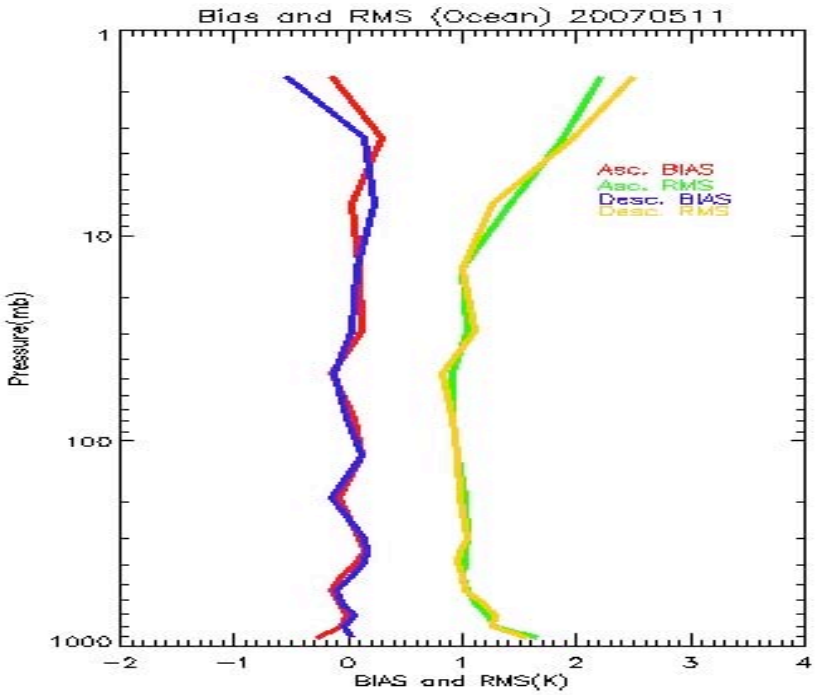
IASI [2500cm−1] Granule−125 20070910



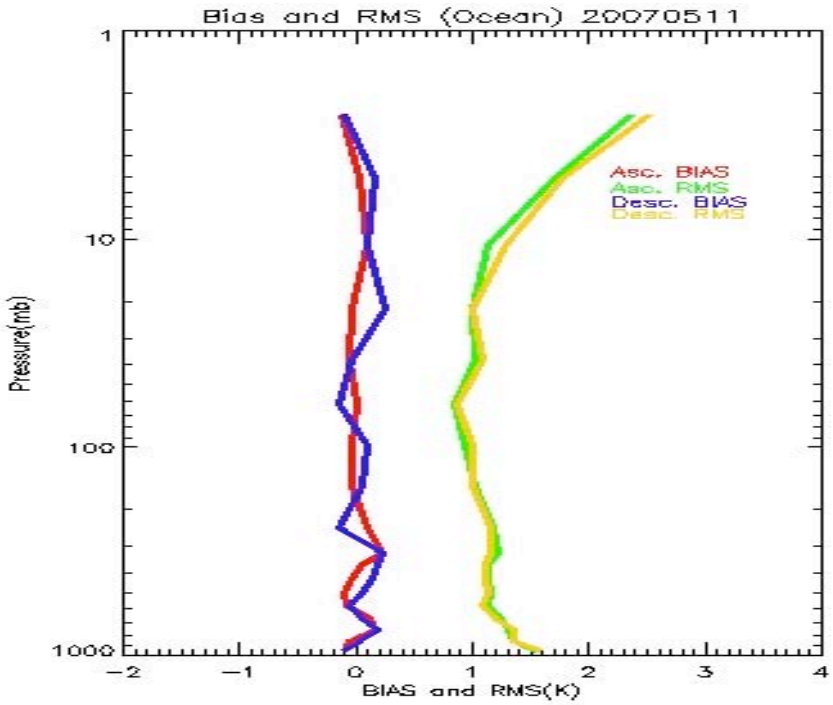
IASI [2500cm−1] Granule−125 20070910

IASI and AIRS Regression Temperature Retrieval Accuracy

IASI



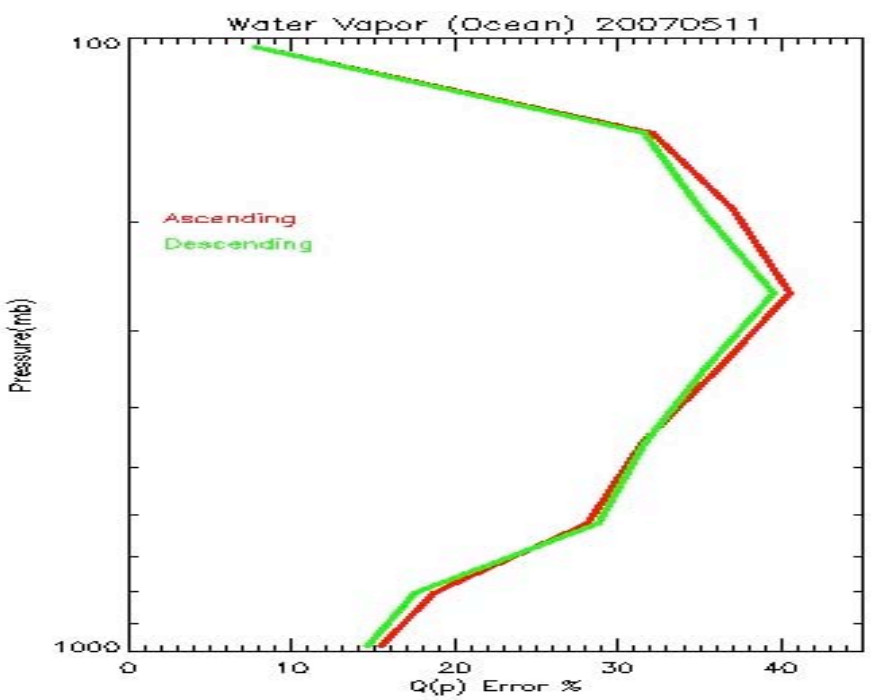
AIRS



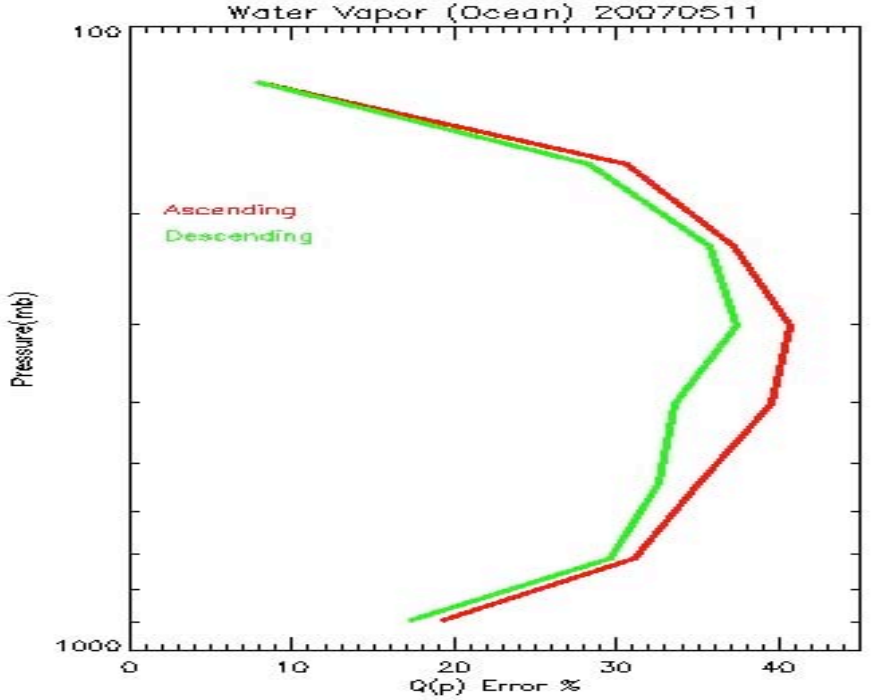
Independent dataset (ocean only)

IASI and AIRS Regression Moisture Retrieval Accuracy

IASI

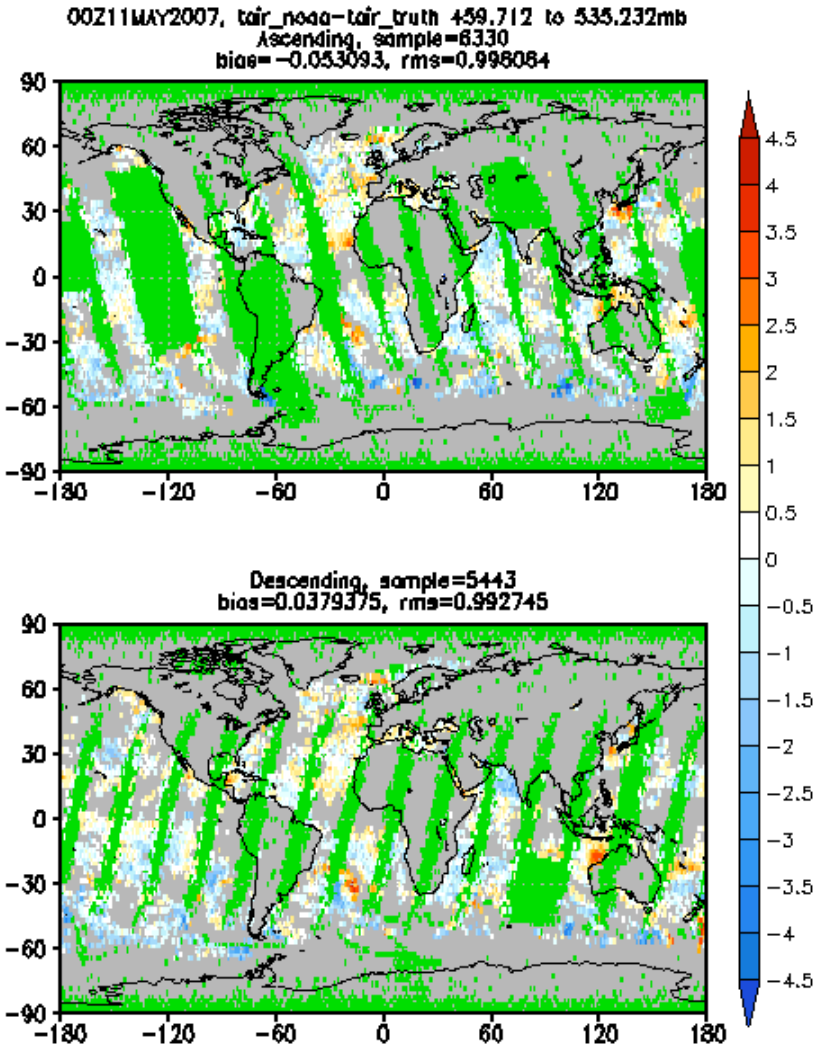


AIRS

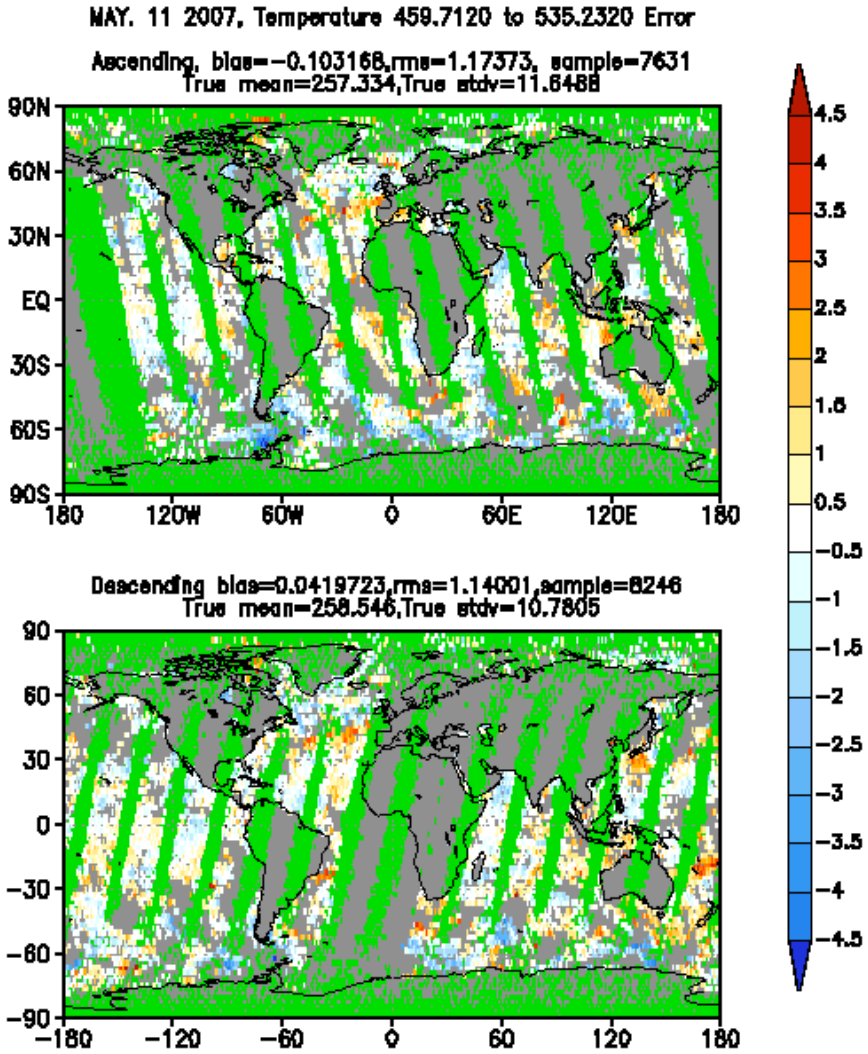


Independent dataset (ocean only)

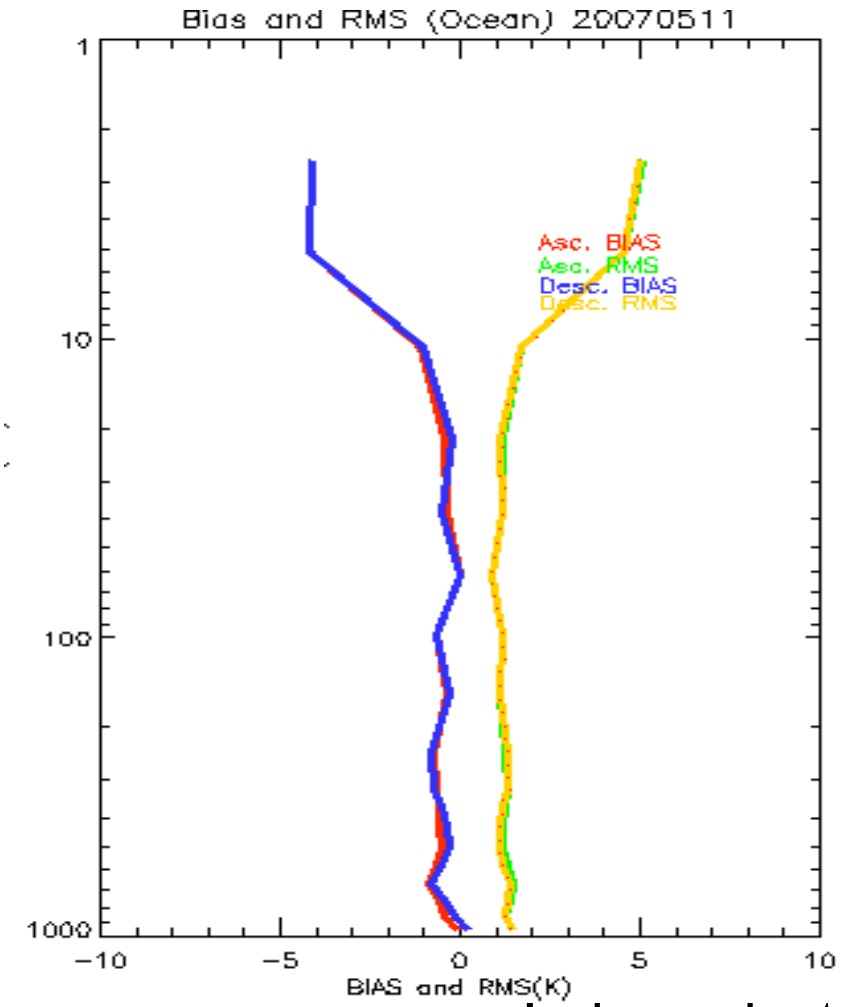
IASI

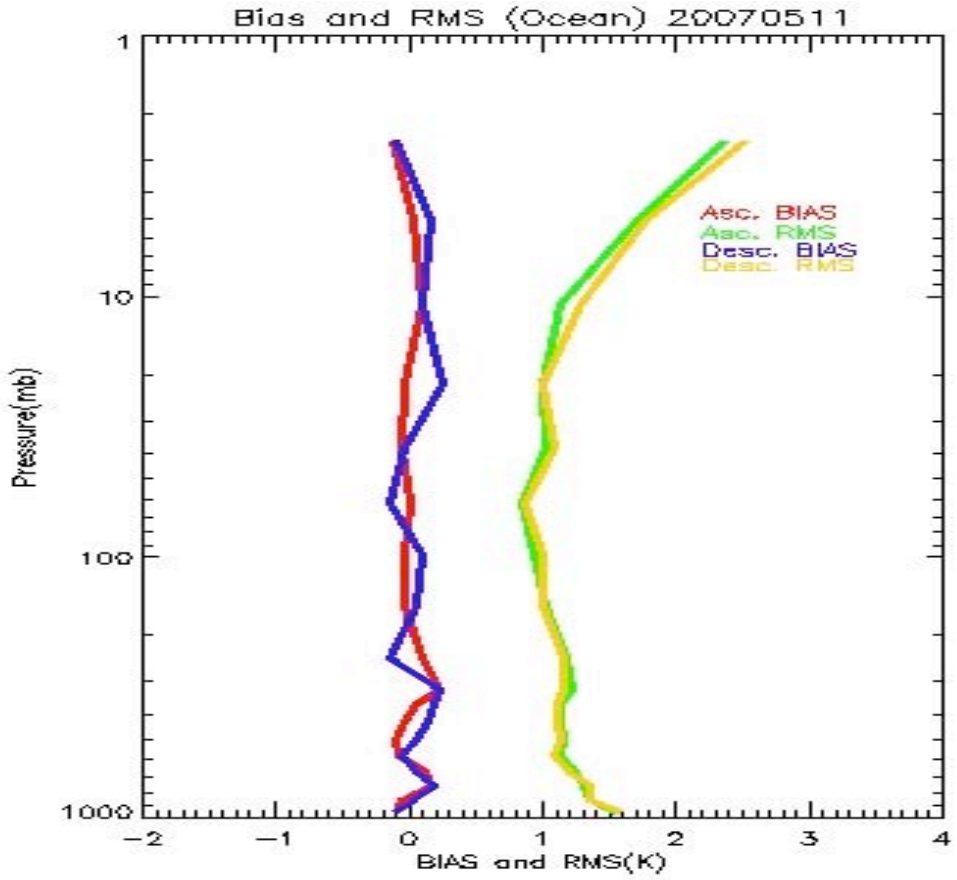

00Z11MAY2007, tair_noaa-tair_truth 459.712 to 535.232mb
Ascending, sample=6330
bias=-0.053093, rms=0.998084
Descending, sample=5443
bias=0.0379375, rms=0.992745
90
60
30
0
-30
-60
-90
-180
-120
-60
0
60
120
180
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5

AIRS


MAY. 11 2007, Temperature 459.7120 to 535.2320 Error
Ascending, bias=-0.103168,rms=1.17373, sample=7631
True mean=257.334,True stdv=11.6488
Descending bias=0.0419723,rms=1.14001,sample=8246
True mean=258.546,True stdv=10.7805
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
90
60
30
0
-30
-60
-90
-180
-120
-60
0
60
120
180
4.5
4
3.5
3
2.5
2
1.5
1
0.5
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5

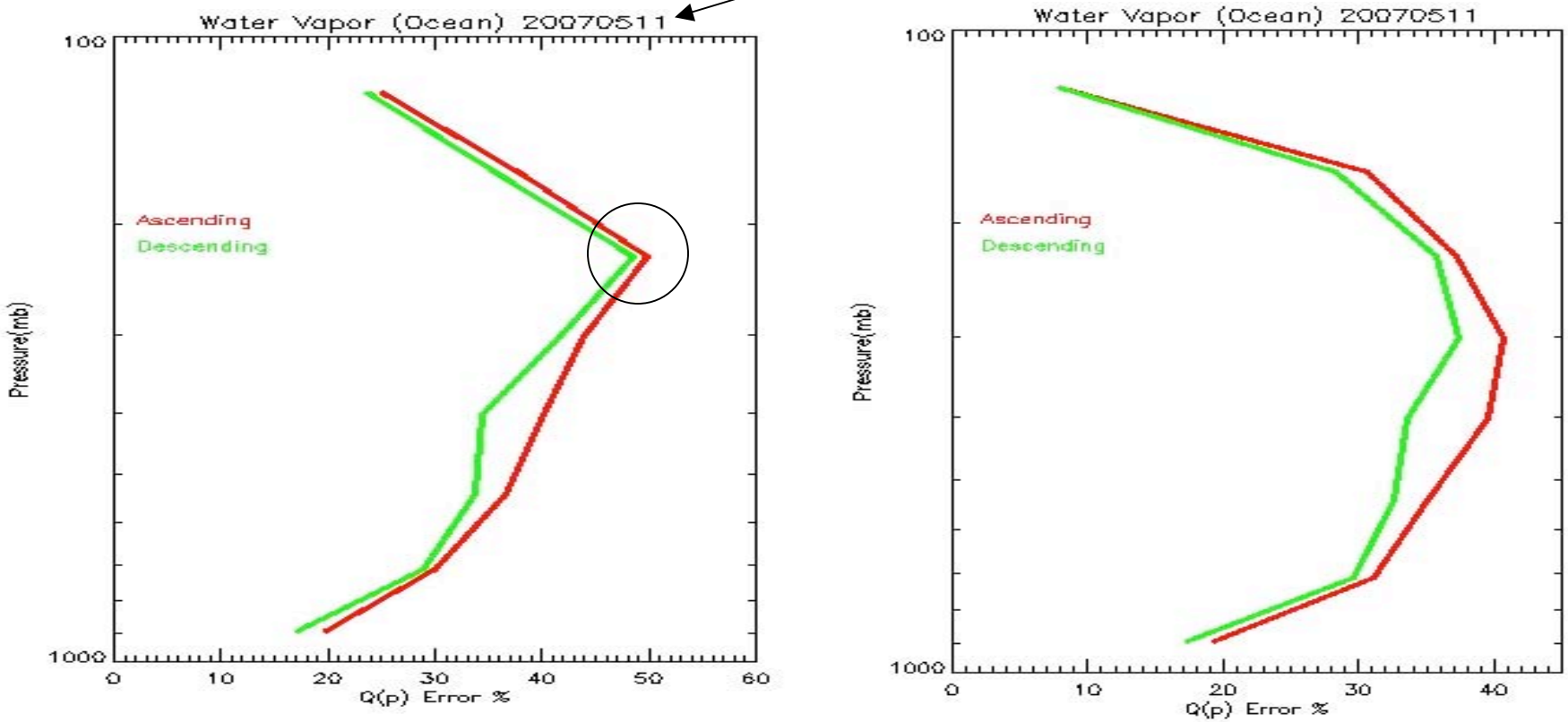
AIRS Regression Retrieval—Temperature Profile (opr coef vs exp)



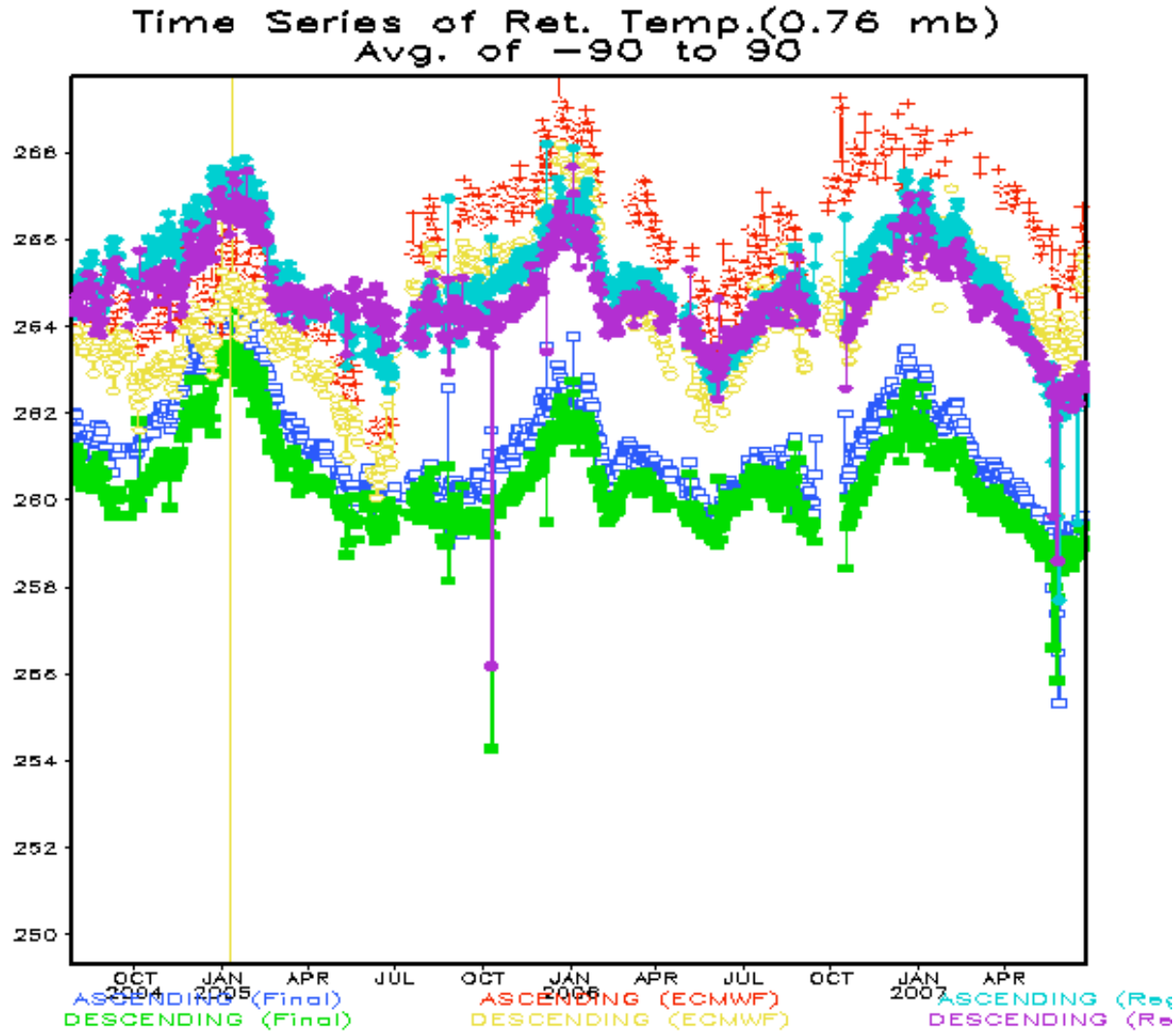


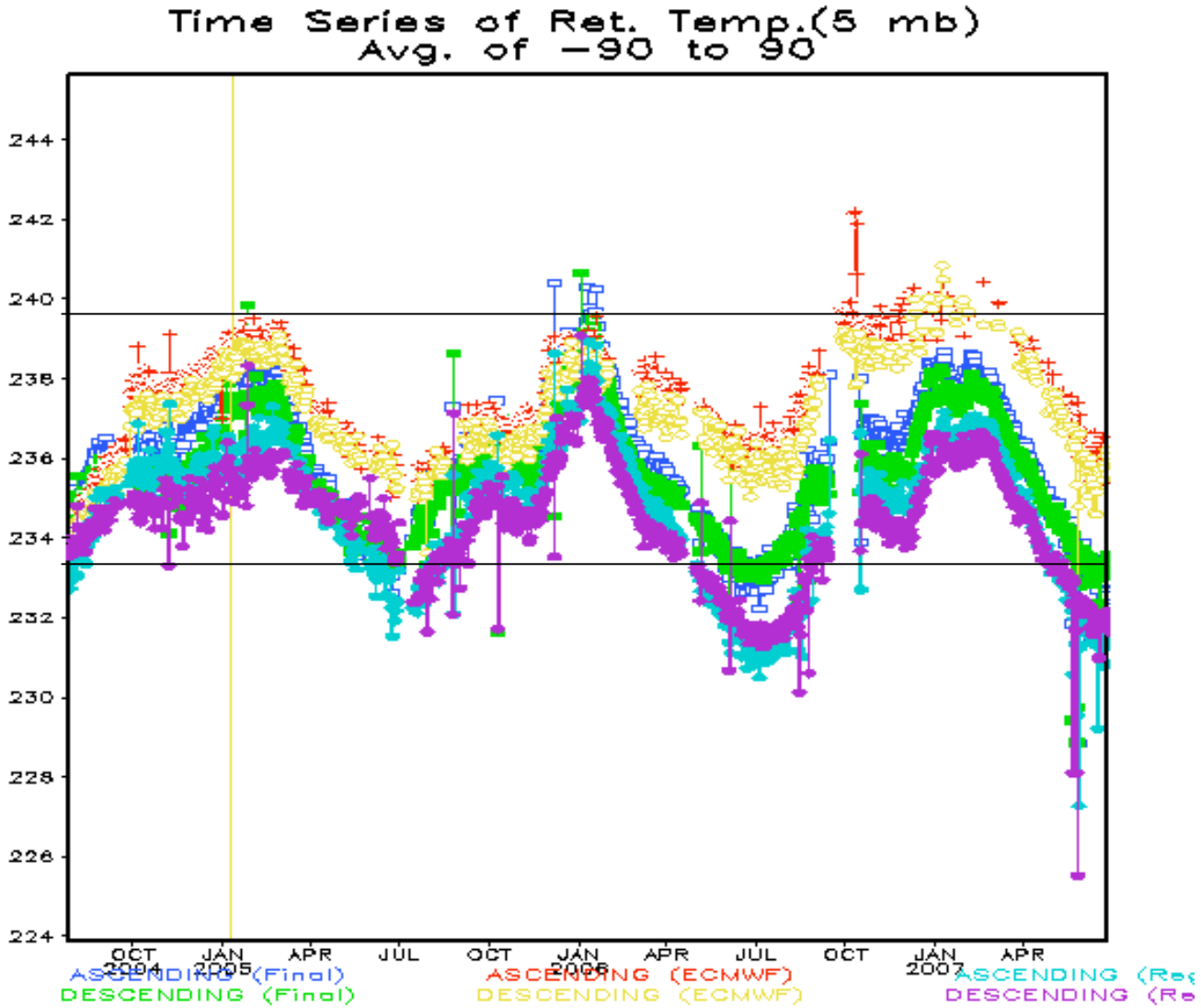
Independent dataset (ocean only)

AIRS Regression Retrieval—Temperature Profile (opr vs exp)



Independent dataset (ocean only)

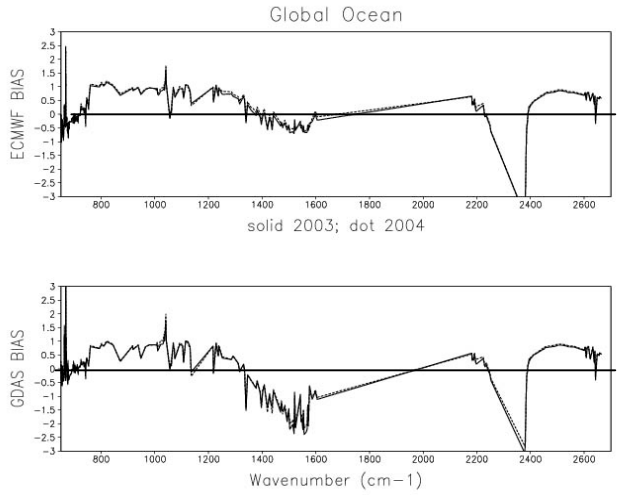

Time Series of Ret. Temp.(0.76 mb)
Avg. of −90 to 90
268
266
264
262
260
258
256
254
252
250
OCT
2004
JAN
2005
APR
JUL
OCT
JAN
2006
APR
JUL
OCT
JAN
2007
APR
ASCENDING (Final)
DESCENDING (Final)
ASCENDING (ECMWF)
DESCENDING (ECMWF)
ASCENDING (Re
DESCENDING (Re


Time Series of Ret. Temp.(5 mb)
Avg. of −90 to 90
244
242
240
238
236
234
232
230
228
226
224
OCT
2004
JAN
2005
APR
JUL
OCT
JAN
2006
APR
JUL
OCT
JAN
2007
APR
ASCENDING (Final)
DESCENDING (Final)
ASCENDING (ECMWF)
DESCENDING (ECMWF)
ASCENDING (Re
DESCENDING (Re

Generation of AIRS Radiance Dataset for Climate Studies

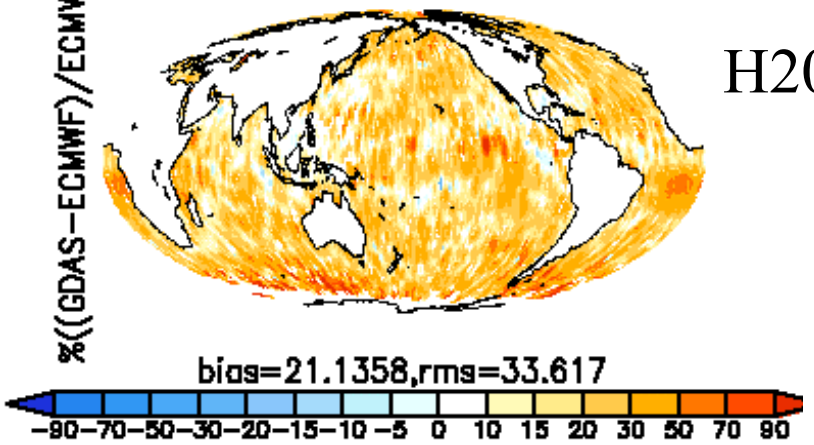
Applications of Mapped Spectrally Resolved Radiances

- Compare radiances with simulated radiances from model analyses
- Compare different years to see how the outgoing infrared radiances have changed.

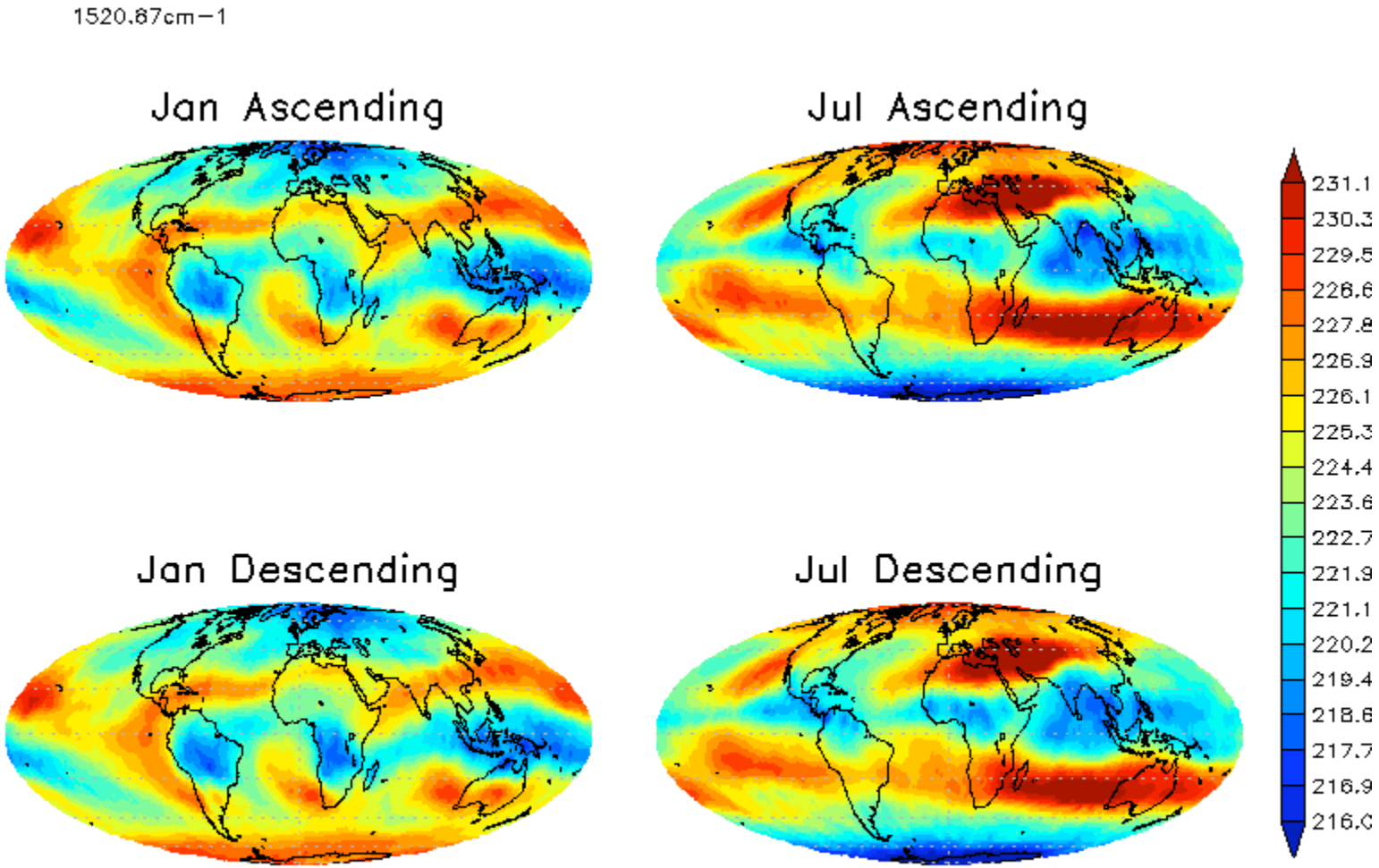


NCEP – ECMWF Above 500 mb

H20

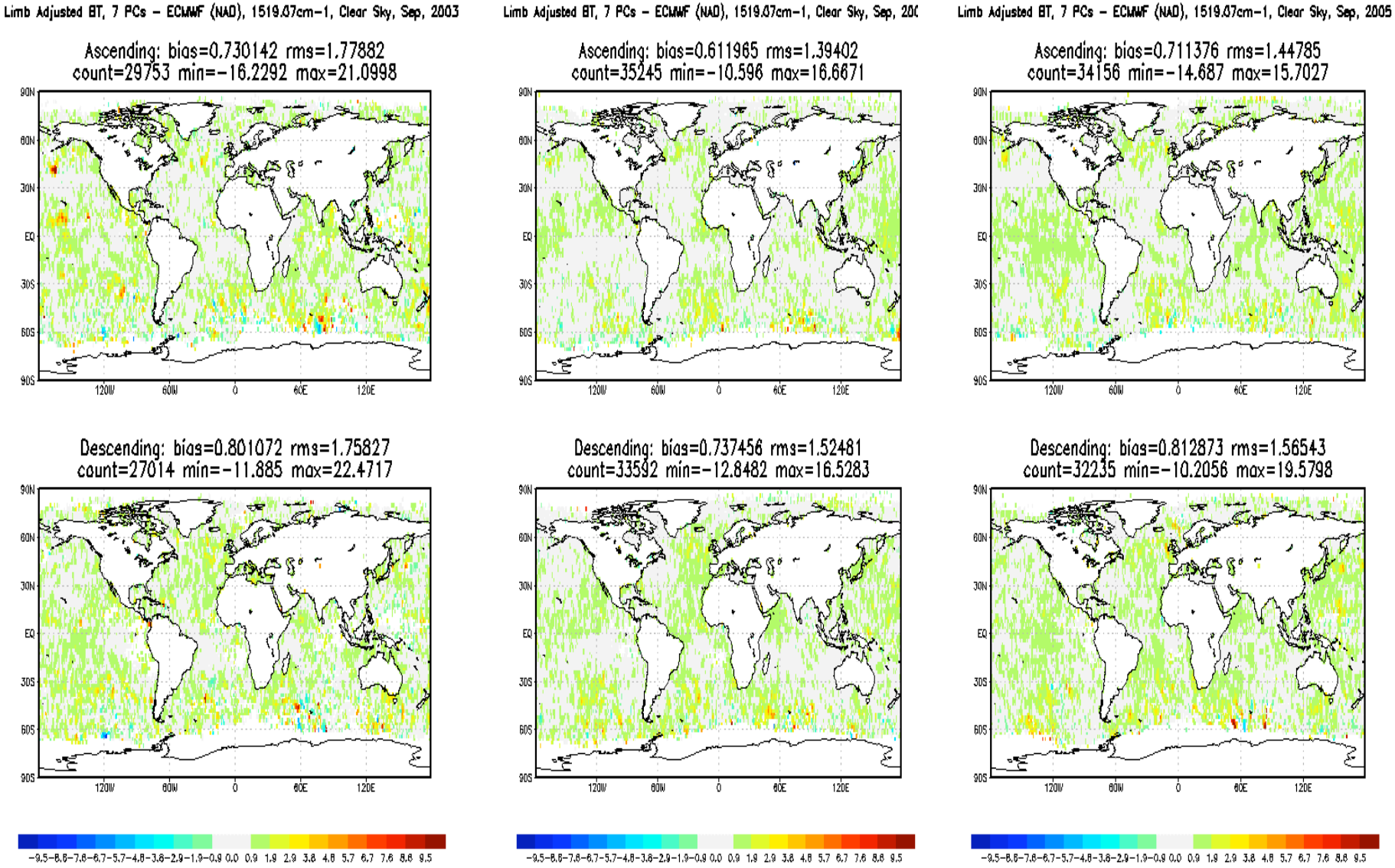


Water – Upper Troposphere



Radiance Climate Dataset detected jump in ECMWF moisture analysis after update to their adaptive bias tuning

Observed AIRS minus ECMWF Simulated AIRS for Upper Trop. Water Vapor



2003

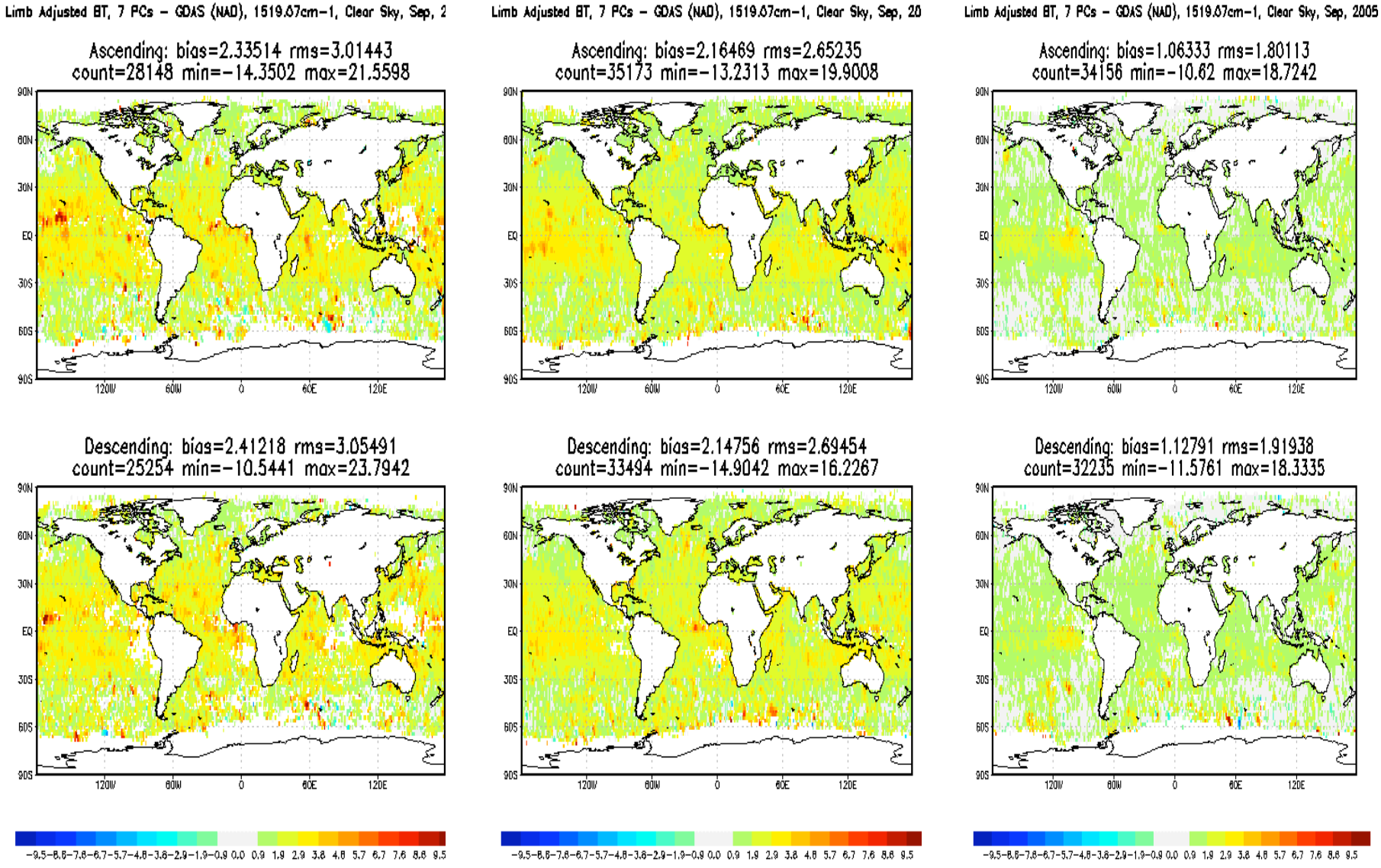
270 mb

2004

2005

AIRS assimilated operationally

Observed AIRS minus NCEP Simulated AIRS for Upper Trop. Water Vapor



2003

2004

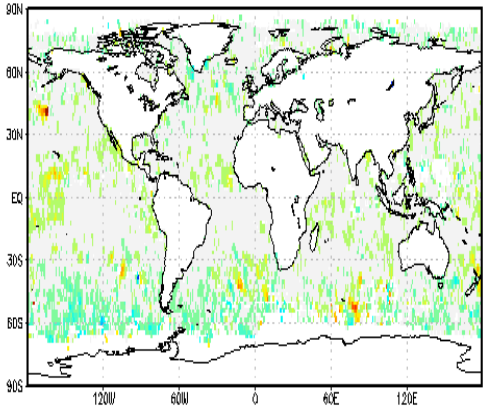
2005

270 mb

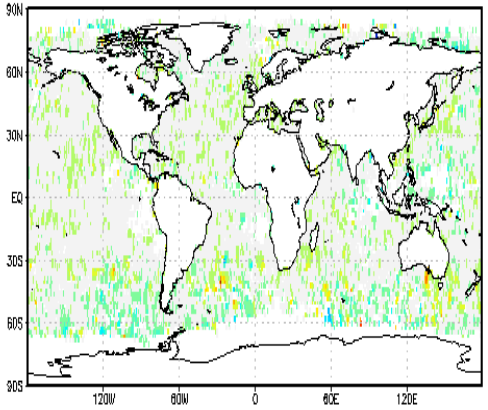
AIRS assimilated operationally

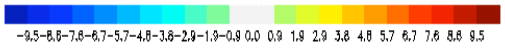
Limb Adjusted BT, 7 PCs – ECMWF (NAD), 1598.49cm-1, Clear Sky, Sep, 2003

Ascending: bias=0.102696 rms=1.51404
count=29753 min=-12.781 max=18.1715



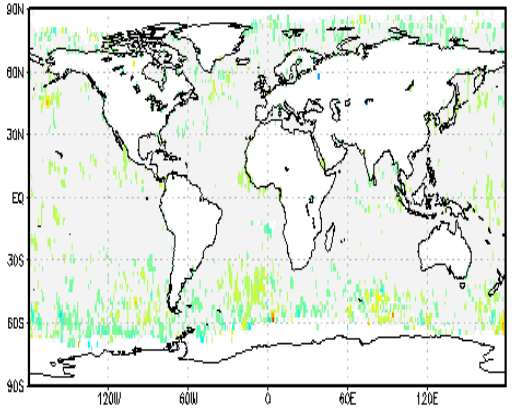
Descending: bias=0.162349 rms=1.4457
count=27014 min=-11.1455 max=17.0494



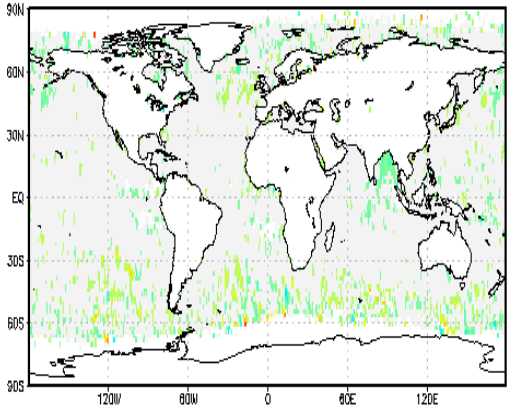


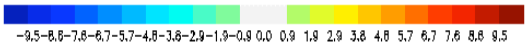
Limb Adjusted BT, 7 PCs – ECMWF (NAD), 1598.49cm-1, Clear Sky, Sep, 2004

Ascending: bias=-0.00965988 rms=1.12849
count=35245 min=-10.0071 max=16.4171



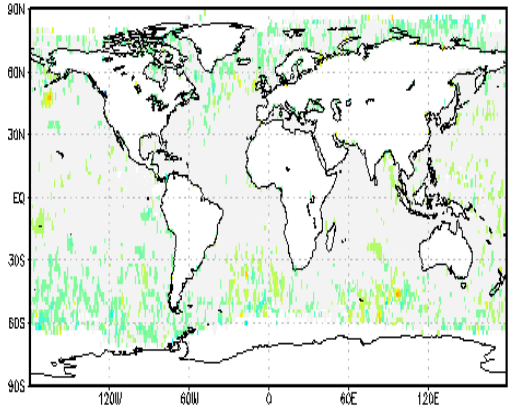
Descending: bias=0.0265201 rms=1.18533
count=33592 min=-11.5689 max=13.0889



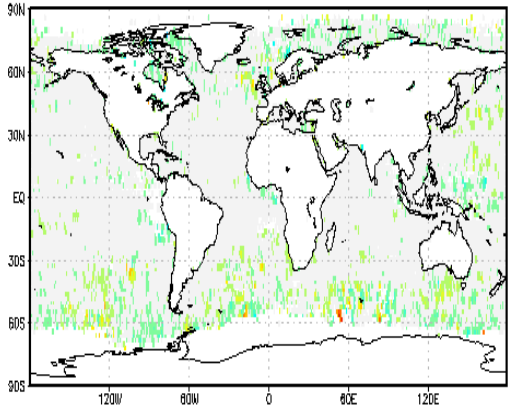


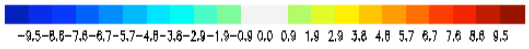
Limb Adjusted BT, 7 PCs – ECMWF (NAD), 1598.49cm-1, Clear Sky, Sep, 2005

Ascending: bias=-0.104855 rms=1.17339
count=34156 min=-12.2345 max=14.0103



Descending: bias=-0.0162446 rms=1.22355
count=32235 min=-9.85136 max=12.5322



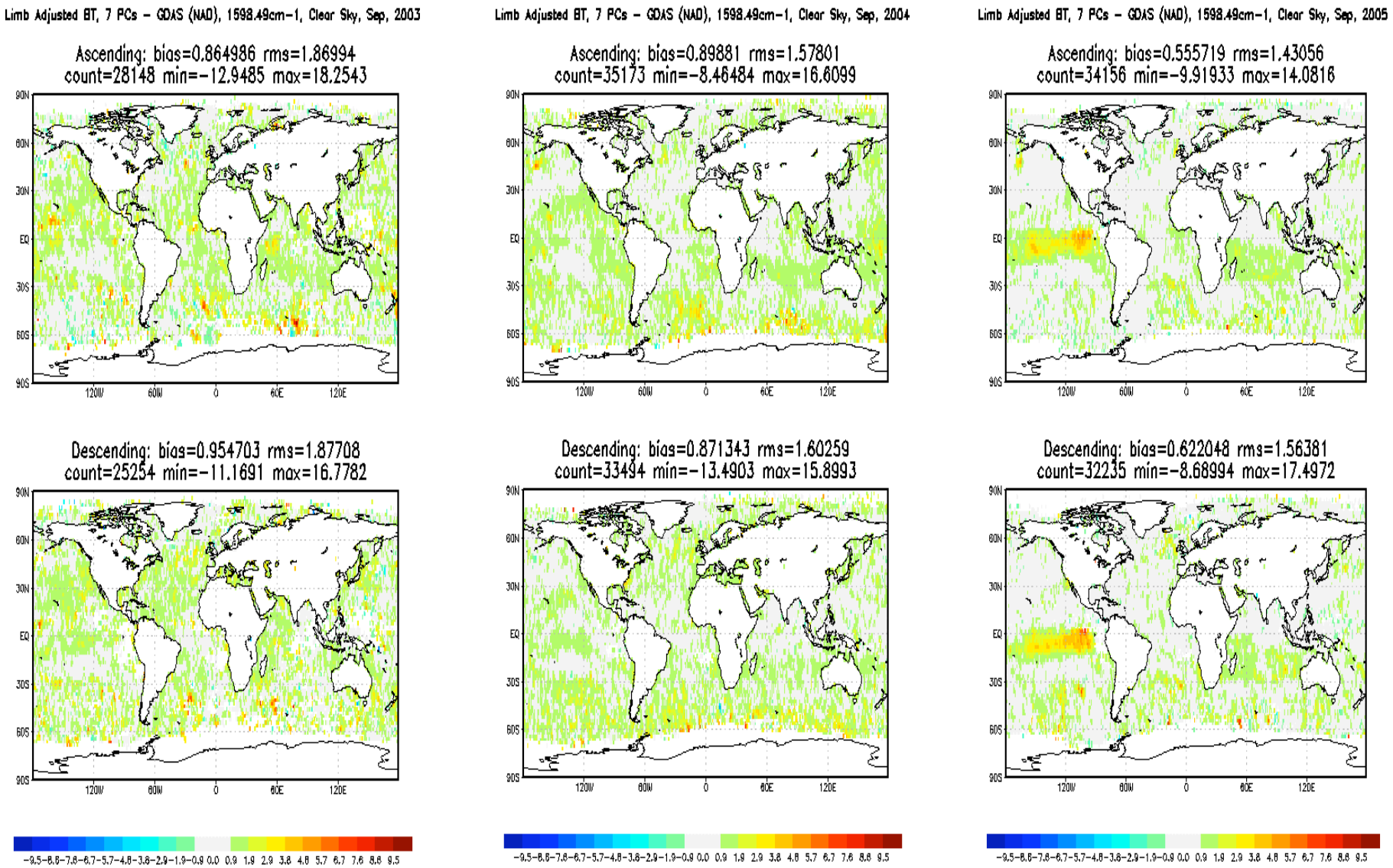


520 mb

2004

2005

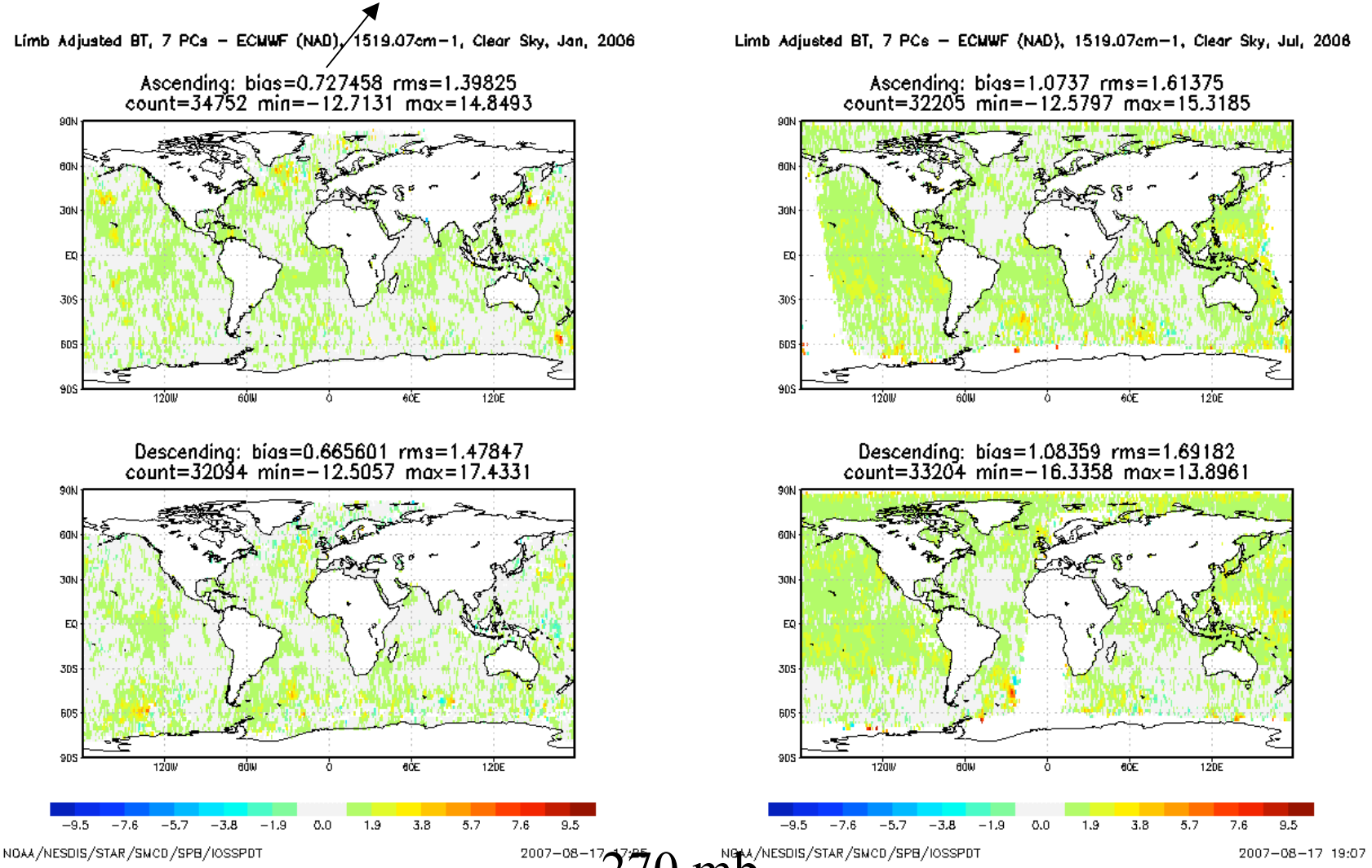
AIRS assimilated operationally



520 mb

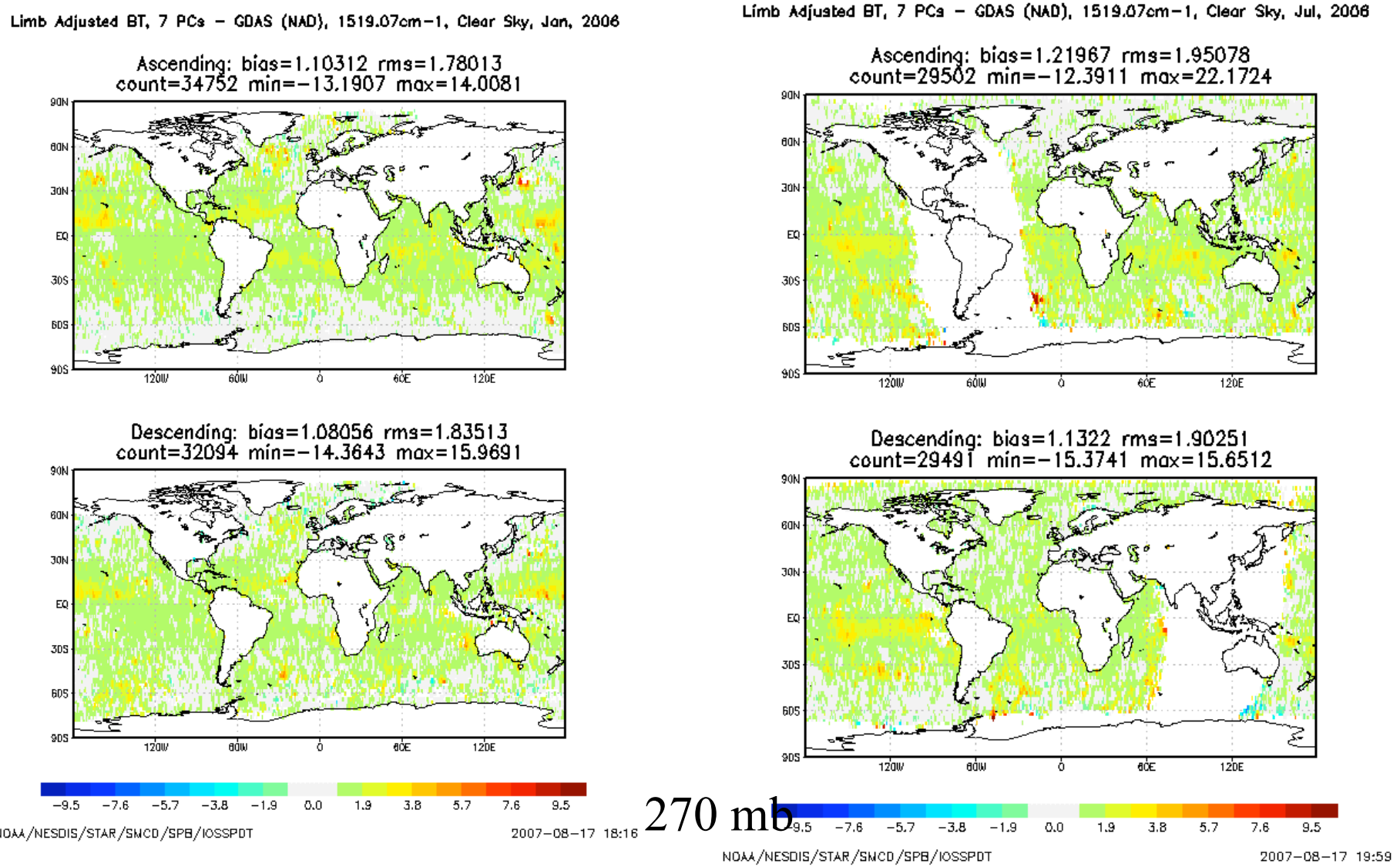
AIRS assimilated operationally

Consistent with Sept 03,04,05



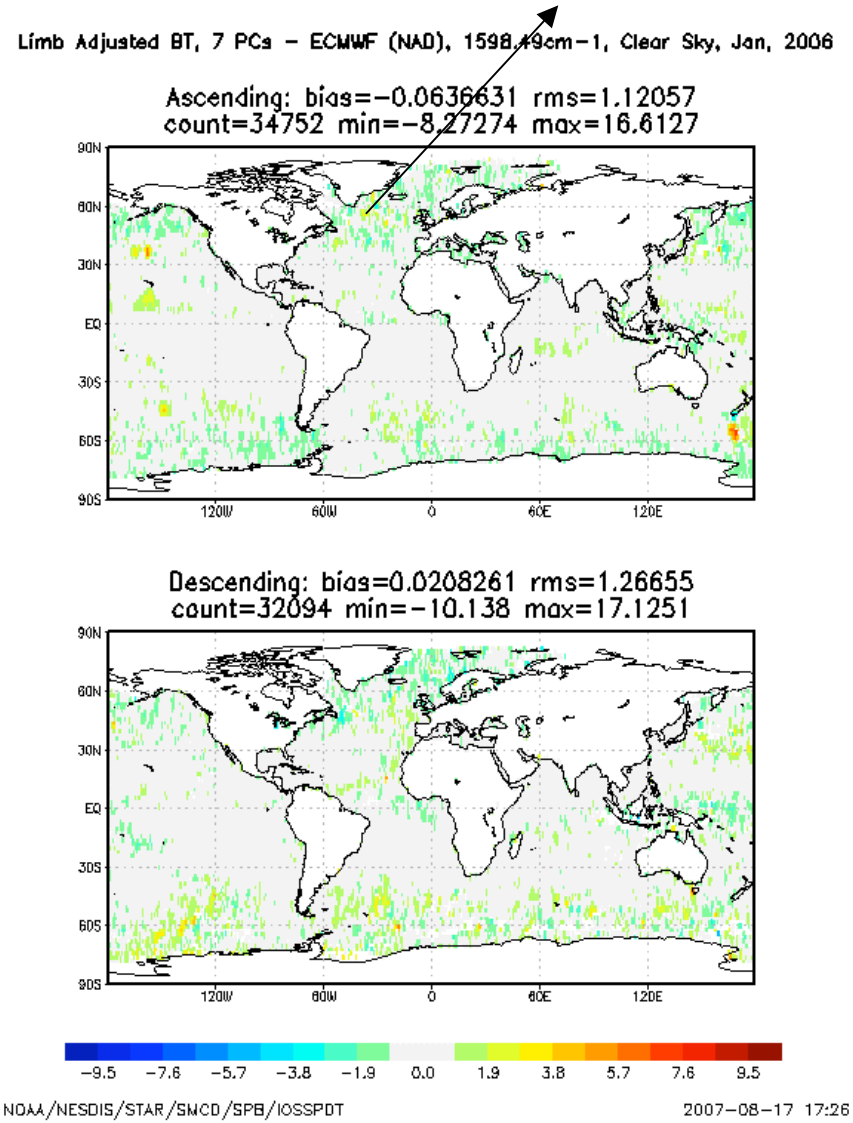
270 mb

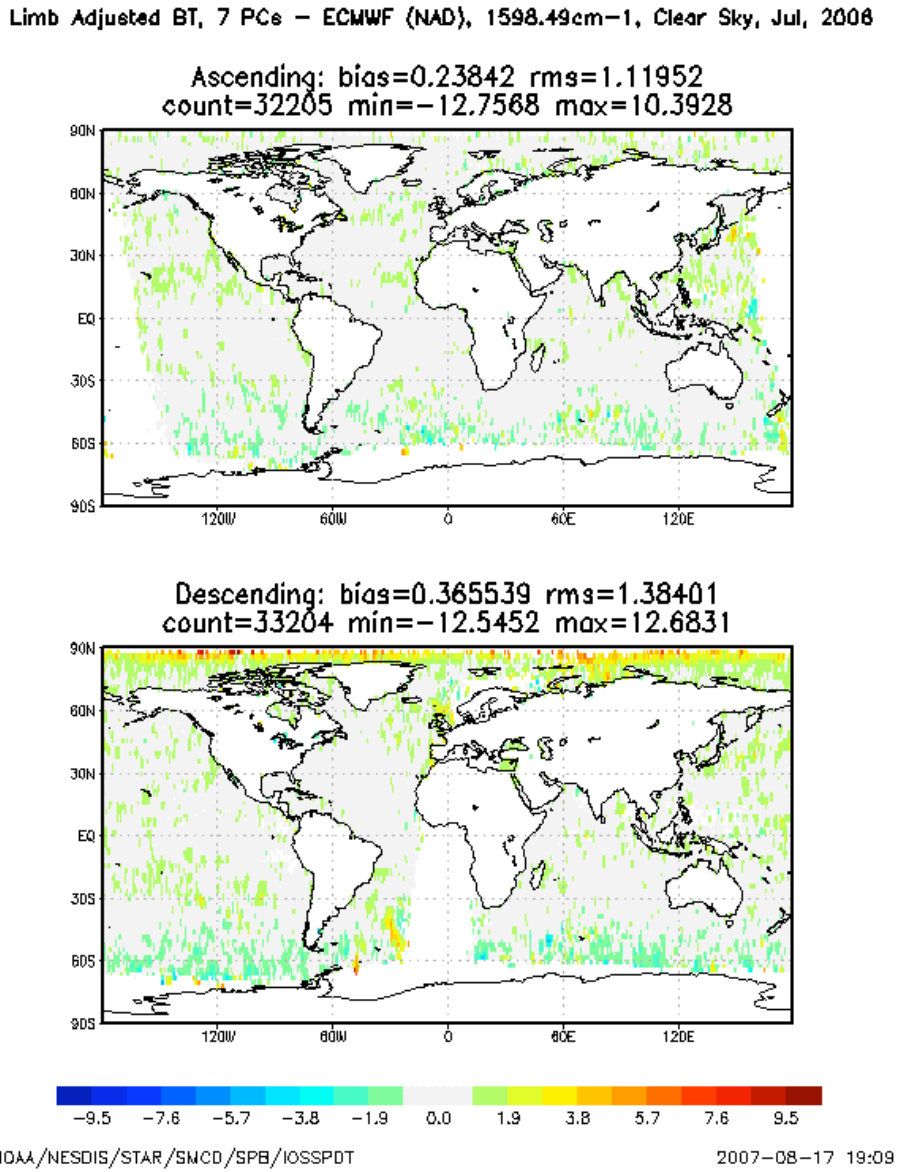
GDAS consistent with Sept 05



270 mb

Consistent with Sept 03,04,05





520 mb

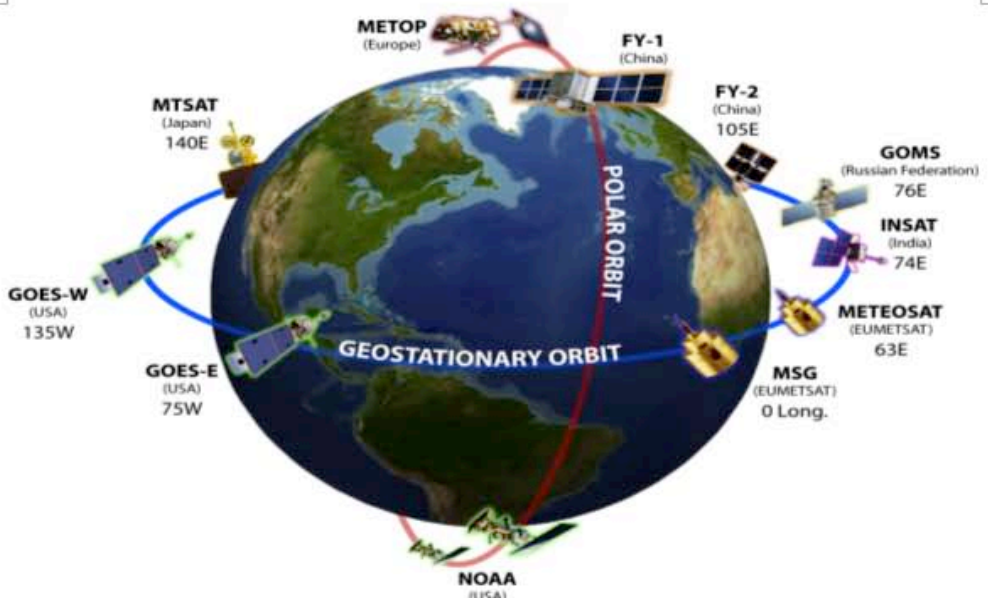
Summary

- Continue IASI PCA research
- Compare IASI and AIRS retrievals
- Complete 2003-2007 AIRS radiance climate dataset.
- Begin generating IASI radiance climate dataset.
- IASI level 2 product will be operational at NESDIS in June 2008

Summary

- IASI and AIRS are critical for satellite intercalibration/characterization of other key observing systems (e.g International Geostationary satellites)
- New WMO Global Space-based Intercalibration System (GSICS) led by NESDIS
- Establish stability of IASI using AIRS

Organizations contributing to GSICS

- NOAA
- NIST
- NASA
- EUMETSAT
- CNES
- CMA
- JMA
- KMA

GSICS current focus is on the intercalibration of operational satellites, and makes use of key research instruments such as AIRS and MODIS to intercalibration the operational instruments